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ELECTRICAL WORLD AND ENGINEER.

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THE PRESIDENTIAL ELECTION.

General surprise has been expressed at the earliness of the hour at which the result of the Presidential election this week was known all over the country. By 7 o'clock on Tuesday evening the indicatory beams of the searchlight, the bulletins on the lantern sheets and the announcements on the newspaper boards gave the results so definitely as to leave no doubt in the mind of any man as to how the country, the State or the city had voted. It seems to us that a great deal of credit is due the telegraphic and telephonic agencies that effected so swiftly and so smoothly this unprecedented collection and distribution of important news. Of course, there was a good deal of inference in the early figures, but even these inferences depended upon the celerity with which the fundamental data reached the expert calculators, over the wire.

The telegraph companies had made their usual arrangements with wonted efficiency, but it is apparent that the wider diffusion of the telephone in the last four years must be regarded as the great agency by which work of this kind is now done. Our observation has been that the news from the rural districts has become available as quickly as that from a city precinct, and hence the summation of the vote is the more quickly reached. This is a definite gain in a great many ways, and is another of the obvious benefits conferred by the electrical communication of news. It might be said that this year, the universally fine weather helped materially and that electricity cannot well claim all the dry roads any more than Republicans can assert a right to all the "prosperity." On the contrary, we opine that the independence of the electrical circuits of weather and other physical conditions should from now on render the early knowledge of election results something to be counted on with absolute confidence, and as being in itself a great safeguard against tampering with the figures or the sanctity of the ballot. In 1884 the crowd howled for days around City Hall Square, New York, in agonized doubt over figures from up-State counties. In 1904 the sounder and the telephone had brought in the exact returns from the same regions to the same center of agitated hopes and fears, within an hour or two, and the flash lights notified millions of citizens around the country almost before the evening stars came out.

ALUMINODE ANODE FILMS.

Aluminum is in many ways a wonderful substance, albeit in the natural world most of it is oxydized, and turned to clay. Its avidity for oxygen is one of its most salient characteristics. It is said that we never see the metal, directly, in air, but always, and only, through a veil of superficial oxide, which forms on its free surface with marvelous rapidity. It is stated that if a fresh surface of aluminum be prepared by scraping with a knife, the oxygen of the air runs in as fast as the scale is peeled off, and keeps close behind the knife blade. If it were not for this superficial scale of oxide, which acts as a barrier to further action, the metal would burn up, or deflagrate, in air. The large amount of heat developed by thermit, a mixture of powdered aluminum with oxygen-giving substances, bears witness to the activity of the oxydizing process when completed.

When a plate of aluminum is made the anode, or incoming current bearer, of a bath containing a suitable electrolyte, and is opposed to some other conductor, say carbon, as cathode, it rapidly becomes coated with a tough film that is capable in some instances

of being detached in fragments. This film has a relatively high resistivity and dielectric strength, so that it acts as a barrier to the current, and requires a relatively high voltage to overcome. If, however, the current through the cell be reversed, so as to flow from the carbon through the electrolyte to the aluminum, thereby tending to liberate hydrogen at the surface of the latter, the film breaks down in spots, and gives passage to the current. The action proceeds so rapidly that if an alternating current of commercial frequency be passed through the bath, the closing and opening of the film gateways occurs with like frequency. The semi-waves or impulses that have the aluminum for anode thus get throttled by resistance, or cut off more or less, while the opposite intervening impulses get through. Such a bath, or electrolytic cell, forms a rectifier of alternating currents, and can be arranged to stand 100 volts or more, although the experiment is usually demonstrated with about 20 volts per cell in a series battery. Unfortunately, the valve action is not clear enough for industrial purposes, or we might have aluminum rectifiers in place of the rotary converters of modern substations. To use a steam engineering phrase, the valves wire-draw. That is to say, they are not suddenly closed tightly, and then instantly opened wide. The transition, although rapid, is gradual, and the current that gets through has to encounter, on the average, a fairly large resistance, with consequent loss of energy and obnoxious heating of the cell, so that the aluminum rectifiers hitherto produced are hot and inefficient. However, there is at least one industrial purpose to which the aluminum cell is stated to have been applied, namely, to an automatic cut-off switch in train lighting on Prussian railroads. In that system the generator is mounted on the axle of the car, and is designed for approximately constant terminal e.m.f. over a considerable range in speed. This generator charges a storage battery, that is the immediate source of current to the lamps on the car. When the voltage difference between generator and battery exceeds a certain value an aluminum cell shuts off the current.

It has long been observed that the character and extent of the action depends upon the chemical nature of the electrolytic solution in the cell. The exact composition of the film has been the subject of much discussion. In an article by William R. Mott recently published in *Electrochemical Industries*, the composition and chemical theory of action of the film are discussed. According to the article, the initial action of the current is to produce at the aluminum anode a loose incoherent deposit of aluminum oxide and water, or aluminum hydroxide. As a secondary action, this aluminum hydroxide attracts to itself, or absorbs, the acid radical of the electrolytic solution, to form a hard, dense, insoluble film, or coating, of great dielectric strength. The activity of this secondary action is not the same for different acid radicals in solution, but depends upon their valency, in geometrical progression. If, for instance, the activity of a divalent radical is, say, 20 times that of a monovalent radical, the activity of a trivalent radical will be 20 times that of a divalent radical; that is to say, 400 times that of a monovalent radical. The dielectric strength of the film is stated to be connected with the secondary activity. For this reason the critical voltage of an aluminum cell with a citrate or phosphate solution (trivalent radical) is some ten times greater than the voltage of a similar cell with a sulphate solution (bivalent radical). The latter in turn is some ten times greater than the voltage of a similar cell with a sulphate solution (bivalent radical). The latter in turn is some ten times greater than the voltage of a cell with a chloride or nitrate solution (monovalent radical). This method of analysis certainly throws light upon a subject that has been very obscure, and if further investigation sustains the hypothesis, the experimentalist will be thereby enabled to extend his researches among the numerous polyvalent radical solutions that have not yet been investigated, and where most successful valve action might be predicated.

THE VALUE OF WATER STORAGE.

To those who live in an arid region it needs no discussion to prove that water is valuable when applied to irrigation, but recent developments in power production have emphasized the need of improvement in dealing with so valuable a thing as a mountain stream whatever may be the primary purpose in using it. It is high time to inculcate economy in this respect, for in very many hydraulic plants there is steady waste of an altogether preventable kind. Until recently nearly every power plant in the country which used water at high head secured its speed regulation at moderate load by deflecting the working stream away from the wheel and shooting the surplus water into the tail-race. At the present time some plants are avoiding this waste and securing good results by using a stream-constrictive nozzle, but the majority are still going along in the old wasteful way. It seems sometimes almost impossible to inculcate the commercial value of storage for power purposes. And singularly enough it seems better understood in the East where storage is difficult than in the West, where it is often relatively easy. Water for irrigation is stored without hesitancy, but there are very many power plants running absolutely without storage in localities where it would not be at all difficult or undesirable to obtain it.

At a starting point take the easily remembered fact that at 500 feet head 100 cubic feet of water represents one electrical horse-power-hour delivered at the station, with liberal allowances all around. Consequently, a reservoir 200 ft. square and 10 ft. deep contains water enough to give 4,000 hp-hours. This would easily carry an additional load of 1,000 hp over the peak of the load. The pecuniary value of this added capacity needs no comment. Such a reservoir even if wholly artificial would generally pay for itself the first year if the market called for additional power. But this is not the whole story by any means. If such a reservoir were placed, as it should be when possible, at the end of any canals or open flumes included in the hydraulic system, the capacity of the reservoir would be available if judiciously employed for carrying the load during repairs on the upper hydraulic works, thus checking one cause for interruptions of service. Where, as now frequently happens, two or more plants co-operate in a single transmission system, storage of water would enable all the reserve capacity of one plant to be called into instant service in case of breakdown of another plant on the same system, thus improving the general reliability of the transmission as a whole. Such minor uses of reservoirs are almost self-evident, even in case of moderate heads, but at heads like that assumed there is a larger field open which in the future will assume considerable importance. As hydraulic plants are generally arranged, the output available for sale is limited by the minimum stage of the water. At the normal or high state of the water the available power may be ten times as great, but it cannot be utilized, from its failure in continuity. In many hydraulic plants in the older sections of the country, the deficit is remedied by auxiliary steam plants. But although steam plants are used in the West to a certain extent, notably in the great Utah system of transmission, the situation is often difficult owing to the comparatively long period of very low water. In some Eastern powers the need for steam auxiliaries comes not at low water but at brief periods of high water when the head is drowned out.

Now truly astonishing things can be done by storage at high heads, as the irrigation engineers realize plainly from their standpoint, disregarding head. Suppose one has a chance to back up

the water over a hundred-acre pond by a dam twenty or twenty-five feet high even. At twenty feet depth of storage one could draw from the pond an average of 1,000 hp for 12 hours per day over a period of more than ten weeks, and a little more depth would carry the output over practically the entire dry season. In other words, at these high heads one can actually store water enough to cover the seasonal variations of flow without unreasonable expense. The revenue from an extra thousand horse-power sold would pay interest, expenses and a handsome profit on a much greater initial cost than would generally be required for the establishment of such a pond. There has been upon the whole far too little attention paid to storage under these high heads that actually make it most profitable. From the power standpoint the cost of storage is inversely as the head, and yet the most perfect examples of storage on a large scale for power purposes are to be found in some of the streams in the East used for several generations as motive power for mills. Water under high heads is so valuable that throwing it away unused comes in the category of sinful waste. There are hundreds of unutilized powers in the country which have been passed by on account of variable flow. To-day with the resources of electrical power transmission at hand, enabling half a dozen plants to be linked together and utilized as a unit, and allowing power to be economically transmitted a hundred miles or more, every power has a potential importance far greater than ever before. A little skillful storage and the interlinking of stations so as to distribute the load in the most advantageous way, works wonders in the economy of transmission as a whole. The art is young yet, spanning scarcely a decade, and there are many things to learn, not the least of which is the economical employment of water.

THE WHOLESALE DISTRIBUTION OF POWER.

Mr. Parshall's admirable paper before the Electrical Congress on certain English coal power distribution schemes brings forcibly to mind the changes which time has wrought in the matter of electrical supply. In this country even more than in England the primary lighting and power field is already well tilled, not always wisely or skilfully, but still thoroughly enough to make unbroken ground scarce. Consequently, the utilization of natural powers, whether hydraulic or depending on cheap fuel, is hampered by the lack of an available market. Market for cheap power there always is, to be sure, but it can often be reached only by impossible concessions to intermediaries, or at the end of well-nigh interminable struggles. Electric supply has not yet reached the stage of a purely manufacturing business, since as a matter of fact the actual capitalization of an electric supply company is often determined more by its franchise than by the physical value of its plant. Hence, the local markets are jealously guarded, and power from outside sources is looked upon with distrust. Large generating stations can hardly then hope to do a general power retailing business in a country already exploited. This limitation is a pretty rigid one, so that although a given territory may be served by many concerns having individually high generating costs, the temptation for independent capital to enter upon a policy of general supply is very small. But as time has gone on the wisdom of economy has asserted itself and the beginnings of a wholesale trade in electrical energy are manifest. This is one phase of the new situation. The other is the increased ease of covering large areas by an electrical distribution.

It has heretofore become possible to organize electrical developments on a large scale and with a broad view, so as to secure the aggregate market of a great territory, in part through the supply of power at wholesale rates to those who assume the responsibility of purveying it to the consumers, and in part by direct supply to consumers outside the regions already occupied by local supply companies. The Yorkshire and the Lancashire Companies, described by Mr. Parshall, are types of this species of enterprise. The Parliamentary Acts under which they were organized gave broad general rights subject to restrictions preventing interference with vested rights, and clearly recognized in the schedule of maximum rates the conditions of a wholesale business. Of course the engineering problem in such a case is to obtain the maximum advantage from concentration of plant, in first cost, operating expense and load factor. The Lancashire district, for example, contains about 1,200 square miles, in which the power used is estimated at 1,500,000 hp or 1,250 hp per square mile, the latter figure being important in considering enterprises of this character. The Yorkshire district uses about 1,000 hp per square mile. As the power used is mainly in relatively small units, the operating costs are rather large, particularly as the load factors are small. The load factor of the average power customer is estimated at about 25 per cent. in these territories. Here, then, is the problem: to so keep down generating costs by concentration of plant as to permit economical gain in the power costs to the customers. A large plant operated with rigid economy is necessary. Mr. Parshall estimates that the largest plant which can advantageously be employed considering the distribution problem, is about 50,000 kw. This means a considerable group of plants for the entire district served, and the logical outcome will be a network of transmission lines fed at a considerable number of points much as a system of low-tension distribution is fed from scattered sub-stations.

It is a fine conception, this general supply to a great industrial district, and the best of it is that Mr. Parshall is able to show a profit even when beginning work on a rather small scale. The natural process is to start in some exceptionally favorable locality and then to build up the whole system as the business grows. The regions chosen for the work are especially favorable in the large market, on the whole more favorable than could readily be found in this country. We have here a strong tendency toward great concentration of industry in large cities, due to transportation facilities and to the labor market. The result is that the market is largely within territory already pre-empted by local supply companies, for the most part too burdened by high capital charges to undertake successfully a large power business. In so far forth the situation is, singularly enough, less favorable than in England. Our big plants, too, have low operating charges, so that they gain relatively little in themselves buying power at wholesale. Consequently, the establishment of companies like those considered is by no means easy. If one could start *de novo* near any one of our large centers in the general supply of power, a revolution in industrial methods would quickly be accomplished, but under existing circumstances the situation is a difficult one. But there are some regions where it might be successfully attempted, particularly by utilizing cheap coal at the mines backed up perhaps by hydraulic plants wherever possible. As a matter of distribution, the gain from an interlinked network is a very material one, since it keeps down the general cost of the conducting system and assures continuity of service besides increasing very considerably the aggregate power that can be safely sold from plants of a given aggregate output. We are just beginning to learn by experience the gains that can be made by grouping transmission plants, and the lesson should be taken to heart. Perhaps the results reached in these English plants will encourage such enterprises here. If once started they would tend to equalize manufacturing conditions in the territory served and thus would have a healthy tendency toward decentralization. The country as a whole suffers from too great aggregation of population in cities, so that any centrifugal tendency should be welcomed. At all events, the progress of the great English power schemes should be closely watched and a study should be made of the possibility of using the same principles under the somewhat more difficult American conditions.

Landmarks in Electric Traction.

Events of the first importance in electric traction history have crowded together recently. The New York Subway has just gone into successful operation, the latest and best example of modern methods in electric railway practice, and now the official, formal tests are announced of the first high-speed electric passenger locomotive, built by the General Electric Company, for the New York Central & Hudson River Railroad Company. These tests are to

NEW YORK CENTRAL ELECTRIC LOCOMOTIVE.

take place on Saturday, November 12, on the experimental track near Schenectady, in the presence of a notable gathering and under the direct supervision of the electric traction commission of the New York Central Railroad. The electric traction commission consists of Mr. W. J. Wilgus, fifth vice-president of the New York Central, chairman; Edwin B. Katte, secretary, and Messrs. Frank J. Sprague, Bion J. Arnold, George Gibbs and John F. Deems. For this event a very handsome invitation card has been issued to the special guests of the New York Central Company by Mr. Wilgus, having at its top a vignette illustration of the locomotive, which we venture to reproduce herewith. This test, of which a preliminary rehearsal was had about a week ago, is the subject of much interest in electrical and railroad circles, marking as it does definitely the practical and actual beginning of the new régimé fraught with such tremendous possibilities for the trunk railroads of the country and their great terminals.

A Wireless Dinner in London.

A complimentary dinner on the occasion of his departure to the United States was given at the Hotel Cecil to Dr. Lee De Forest by Mr. Frank Z. Maguire, vice-president of the American De Forest Wireless Telegraph Company. Sir William Preece presided, and among those who accepted invitations to be present were Prof. W. E. Ayrton, Mr. J. Swinburne, Mr. A. A. C. Swinton, Prof. G. M. Minchin, Col. H. C. L. Holden, Capt. Lionel James, Admiral Sir J. D. Hay, Mr. S. Barber, Mr. F. C. C. Nielsen, Mr. G. Maclean, Mr. A. L. C. Fell, Mr. J. H. Carson, Sir Dudley Forwood, Mr. E. H. Johnson, Mr. R. Wallace, K.C., and Mr. N. Maskelyne.

Sir W. Preece, in a short speech, said that it was 20 years since he first began to experiment with wireless telegraphy. Of late they had seen how that pride of every Englishman, *The Times,* had been able, by the recent developments of wireless telegraphy, to make them acquainted with events passing around and about Port Arthur very soon after those events had happened. No one had worked harder and had been more successful with wireless telegraphy than Dr. Lee De Forest. An article in *The Times* in August last placed on record the way in which they were indebted to him for the magnificent work done in the China Seas by Capt. Lionel James. He concluded by proposing Dr. Lee De Forest's health, a toast which was warmly welcomed.

Dr. Lee De Forest, in responding, said that as a result of a conference with Capt. Lionel James last year *The Times* wireless war service was inaugurated. This was the first successful utilization in journalistic work, and established new records. From a boat equipped with only 96 ft. of wire, and 1-kw transmitter, messages up to 1,700 words in length were transmitted over distances up to 210 sea miles at a speed of 25 to 35 words a minute, and frequently in face of transmission from any number of Japanese, Russian, German and British vessels. Those dispatches, flashed hot from the graphic pen of Capt. Lionel James, made up a series of pictures of the naval operations before Port Arthur which stood alone in the history of journalism. Dr. Lee De Forest gave an account of the various installations which had been established in the United States. Discussing the relative cost of wireless and land wires, he said that the Western Union estimated the cost of the construction of a single wire at $300 to $400 a mile. According to these figures, a wire from St. Louis to Chicago would at least cost £18,000. The cost of the long-distance wireless stations at Chicago and St. Louis would not exceed £3,000. Recent developments justified the claim that wireless telegraphy could prove of the greatest value to vested interests as a feeder and adjunct to the cable and the telegraph wire.

Sir W. Preece submitted a further toast, that of "The Press," coupling with it the name of Capt. James, who, in response, observed that, although he had been called on by name, he was but the instrument of that great paper which had always done its best to promote every good result of scientific research. In this case it had been willing to take his advice on the particular subject of wireless telegraphy, and it was the advice, not of an expert, but simply that of a man who had always been taught to judge by results. He proceeded to give an account of the difficulties which he had to encounter in the Far East in carrying on the wireless service. He added that the service ceased because the system proved to be of far greater excellence than that used by the Japanese, which, even in favorable circumstances, was not expected to transmit over more than 100 sea miles. There was an element of danger in wireless telegraphy for belligerents which could not be overlooked. He trusted and believed that in his hands, as the instrument of *The Times,* the system was never put to wrong uses, but the possibilities were so enormous that he felt it to be a duty he owed to his country as one of the greatest maritime powers the world had ever seen that they should know exactly what had been discovered in what the chairman had been good enough to call the enterprise of *The Times.* The sooner wireless telegraphy was legislated for by international law the better for all concerned.

Operation of the New York Subway.

The population of New York City has already settled down to quiet acceptance of the New York Subway, and has begun to appreciate some of the benefits and advantages of the new method of transportation. The traffic has been very heavy and on some days has taxed the facilities of the new system. Some of the earlier criticisms have died away, as the road has got down to smooth operation, and has shown its ability to run swiftly with a speed between terminal stations quite unknown in the history of New York City. The chief points apparently susceptible of improvement are the ventilation and the advertisements, although the latter have little to do with the technical merits of the road or its efficacy.

Probably some improved methods of subway ventilation may be adopted, but in the meantime the reports as to vitiated or foul air are decidedly exaggerated. The question has been raised as to the amount of oxygen in the subway, a Dr. August G. Seibert claiming to have found the quantity very insufficient. On this point Dr. C. F. Chandler has made an interesting statement. Dr. Siebert, he said, had stated that the amount of oxygen was only 11 per cent. This could not possibly be true. "The normal amount of oxygen in the air is slightly less than 21 per cent.," said Dr. Chandler. "A person breathing air absorbs into his system 5 per cent. of oxygen and returns to the atmosphere 4 per cent. of carbonic acid gas. In this air which has been exhaled from the lungs a match or cigar will not burn, and it would not support life for any length of time. This air, however, contains 16 per cent. of oxygen, which is 5 per cent. more than Dr. Siebert claims can be found in the subway. If his statement were true health would not only be endangered, but life itself, for a person could not possibly live in such an atmosphere."

Dr. John Bessner Huber, a recognized authority on tuberculosis, took a rather different view of the condition of things. "I agree perfectly with Dr. Siebert," said he, "as to the necessity for finding some way for ventilating the Subway. I have noticed its vitiated air and several physicians have spoken to me about it during the past few days. It is a condition and not a theory that confronts us. It is not one that need cause any panic, it is true, for the average man in good health will not be injured to any extent by his occasional use of the tunnels. Still, I should never recommend to any of my patients daily trips in the Subway. Seriously, there is a phase to the investigations of Dr. Seibert that does or will call for the attention of the health authorities and the medical societies in time, unless some system of properly ventilating the tunnel is devised. That is the health of the employes who are called upon to live for hours in the very devitalized air of the Subway. There is a menace to them, even if they are in the soundest of health."

The Willesden Power House, London, England.

THE North Metropolitan Electric Power Supply Company, of London, has two large power plants furnishing current in bulk to the system and network, and one of these, lately gone into operation, is at Willesden. It is of interest as illustrative of the latest attempts being made to supply the vast area known as the British metropolis, with current, under the difficult conditions there existing, which in the main prevent any vast and economic consolidations of interests and gigantic production of output such as are seen in this country.

The Willesden Urban District covers about seven sequare miles and is, roughly, in the form of an equilateral triangle. In one-third of this area, still entirely rural, there is as yet no demand for electrical supply, while the remainder may be divided into two parts of maximum density, separated by a purely residential district. As there was a good site for the electricity works in the center of one of the dense sections of the area, the "double-current" system of generation and distribution offered an excellent means of supplying the district efficiently. The works supply Willesden proper and Harlesden with continuous current on the three-wire system. High-pressure, three-phase current is transmitted to a large rotary converter sub-station in Salisbury road, Kilburn, which is approximately at the center of the second area, comprising Cricklewood, Willesden Green, part of Kilburn and Brondesbury. As the day loads are small, and a single 300-kw machine is sufficiently large to deal with them for several hours of the day, the generators are of the "double-current" pattern, capable of supplying continuous or alternating current simultaneously. The continuous current is generated directly at a pressure of from 490 to 540 volts, suitable for the 2 × 240-volt network surrounding the works, and this fixes the average pressure at the alternating-current terminals of the same generator at 316 volts, the machines being, as it were, rotary converters driven by engines. Step-up transformers with a ratio of 1:9 are employed, raising the pressure to an average of about 2,850 volts, at which it is transmitted to the sub-station. Three variable-ratio, step-down

FIG. 1.—GENERAL VIEW OF ENGINE ROOM.

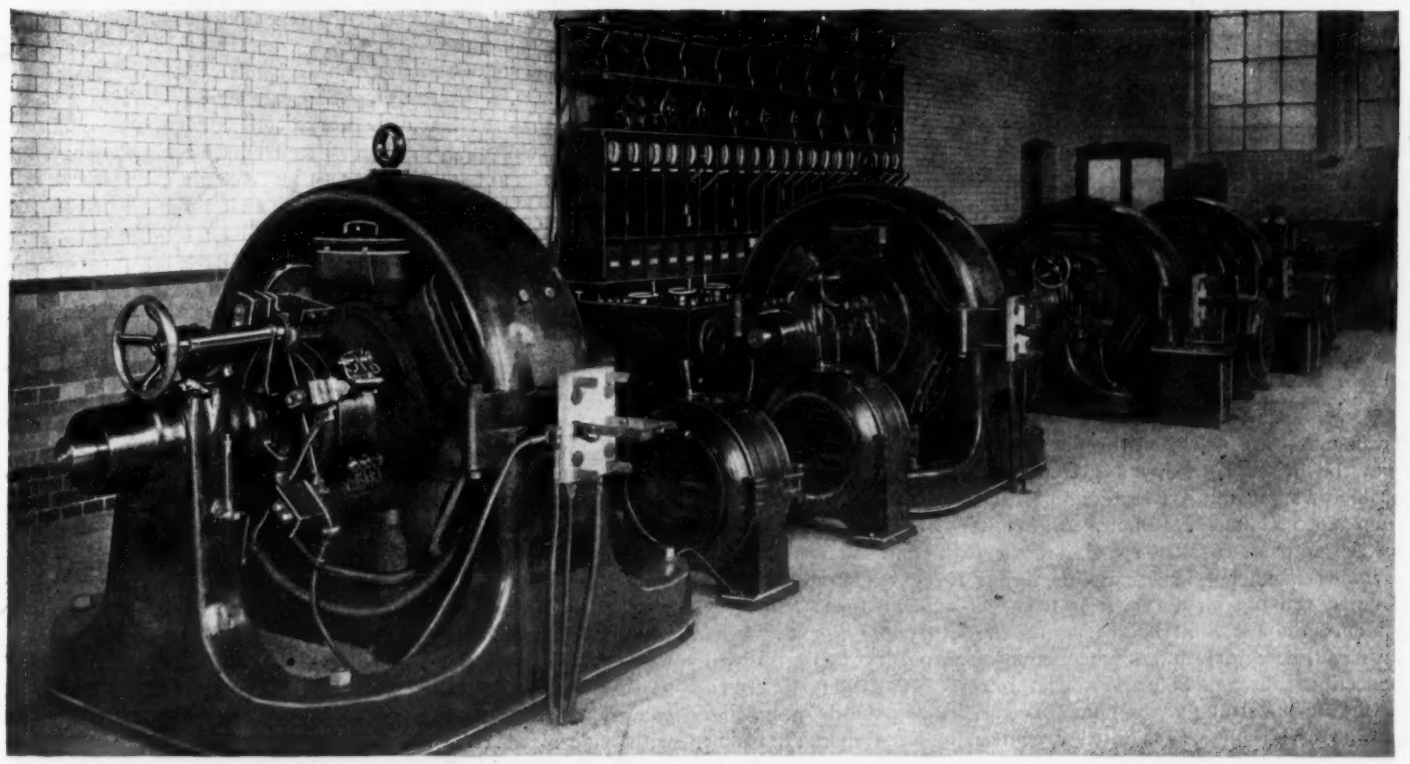


FIG. 2.—CONVERTER ROOM IN SUB-STATION.

transformers and rotary converters once more reduce the pressure down to that suitable for a 2 × 240-volt, three-wire, continuous-current distribution.

The boiler room of the new power house is equipped with four Babcock & Wilcox boilers, in pairs, 180 pounds pressure, with an evaporative capacity of 5,800 pounds per hour, equipped with Green economizers. A useful accessory is an "Ados" registering CO_2 recorder, which is connected to the main flue or to any boiler at will. This apparatus depends on the fact that CO_2 is absorbed by a solution of caustic potash, while the other gases are not. A "motor," which is practically a miniature gasometer and valve driven by the partial vacuum in the chimney, raises and lowers a bottle of glycerine every five minutes and also pumps some of the flue gases into a measuring tube, in which exactly 100 cu. cm. of the gas is trapped with each stroke by the rising and falling of the glycerine. This gas is then driven into a vessel containing the caustic potash solution where the CO_2 is absorbed, the remainder displacing a corresponding volume of the solution. This increases the pressure in a third vessel and raises an inverted cylindrical vessel or "bell" within it, causing a motion of the pen through a simple lever. A chart revolves by clockwork and the pen traces a line on it every five minutes corresponding in length to the proportion of residual gases after the CO_2 is abstracted. Thus the curve so formed, if the chart is inverted, shows the proportion of CO_2 in the flue gases. The apparatus, although somewhat complicated, appears to work well, and the results are of considerable utility in effecting economy in the boiler house.

Two Hall steam feed pumps and one Mather & Platt electrically-

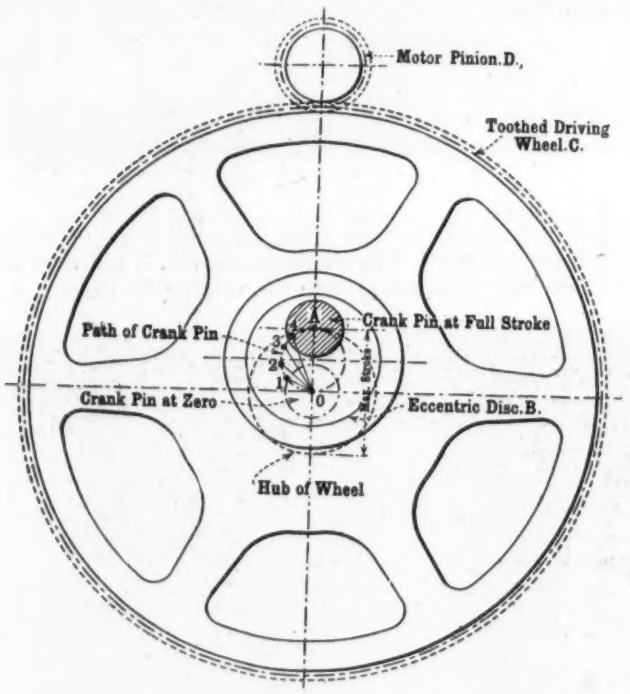


FIG. 3.—ILLUSTRATION OF PRINCIPLE OF FEED PUMP REGULATION.

driven pump are placed in the pump room, which is partitioned off from the boiler house by a glazed screen. The Hall pumps are capable of supplying 3,500 gallons per hour, and the Mather & Platt pump 2,000 gallons per hour. The latter is driven by a 6½-hp electric motor at constant speed, and the regulation is effected in an ingenious manner. The pump itself has three cast-iron cylinders mounted radially on a cast-iron frame at angles of 120°, like the cylinders of a Brotherhood engine, the plungers, which are of gun metal, being driven from a common crank pin through mild steel connecting rods and ball and socket joints. Regulation is effected by varying the stroke of the pump, as explained in the diagram, Fig. 3. The crank pin, *A*, is fixed excentrically on a disc, *B*, fitting into a recess in the hub of a toothed driving wheel, *C*, which is driven by a pinion, *D*, on the shaft of the electric motor. This recess is itself placed excentrically to the periphery of the toothed wheel, *C*, and thus, when the disc, *B*, is rotated by means of gears situated in the hub, the crank pin, *A*, is caused to move in a circle (0—1, 2, 3, 4); at one point (the highest in the diagram) of this circular course the crank pin will be at its maximum distance from the center of revolution of the toothed wheel, and the plungers will, therefore, perform their full length of stroke; at the opposite point of the circle (0) the crank pin will be concentric with the center of revolution of the toothed wheel, and, consequently, will have no action on the connecting rods of the plungers.

The gear which turns the crank disc, as explained above, is an essential feature of the pump. The crank pin is hollow and there are two brake drums at the end. These move excentrically, parallel to the crank disc, but by tightening the brake strap on either brake drum it revolves in relation to the crank pin. The inner periphery of each disc is connected by "sun-and-planet" gear to a spindle within the hollow crank pin, so that this spindle will revolve within the crank pin to the right if one brake strap is tightened, and to the left if the other is tightened. This spindle gears into the disc at its other end, and thus causes the latter to turn. The brake straps are controlled by the same lever, which, if moved upward, tightens one of them, and if moved downward tightens the other. The motor is shunt-wound and runs off the 240-volt, continuous-current circuit, its speed being 550 r.p.m., and that of the pumps 80 strokes per minute.

Fig. 1 is a general view of the engine room taken before the erection of the 600-kw set, showing the 300-kw sets. These three sets consist of compound Ferranti engines driving Westinghouse double-current generators. Contrary to the usual arrangement, the low-pressure cylinders, instead of the high-pressure cylinders, are nearest the boiler house. This puts the condensers in a convenient position against the wall of the boiler house, and there is, moreover, practically no extra length of steam main, as this is carried from the separator to the high-pressure cylinder through the receiver between the two cylinders, which is thus heated with live superheated steam. The engines follow in other respects the standard lines adopted by Messrs. Ferranti. An even turning moment was specified, the irregularity not to exceed ⅓ of 1 per cent. per revolution, and a specially heavy fly-wheel has been provided, weighing 11 tons in the case of the smaller sets and 15 tons on the 600-kw set. The engine speeds are 250 and 214 revolutions, respectively, the number of poles on the generators being 12 and 14, respectively, for a frequency of 25 cycles per second. The generators resemble continuous-current machines rather than alternators, but, of course, the pole pieces are laminated, and they are also fitted with damping coils. The armatures (which are slot-wound) revolve, and the field magnets are fixed. At present the machines run as shunt machines, but there is a compounding series winding which can be included in the circuit. The switch for this is placed on the frame of the machine in the generator pit. Separate exciters are provided, but it is found that the machines work well with shunt excitation. In fact, if it were not for the three slip rings adjoining the commutator, the machines might be taken for ordinary continuous-current railway generators. They are amply dimensioned, and one of the 300-kw machines was run at over 400 kw last winter for several hours at a time every evening without giving the least trouble, and supplying both continuous and three-phase alternating current simultaneously. A fourth set (750 kw) made by the Brush Electrical Engineering Company will be put in shortly.

The mains from the slip rings of the generators lead the low-tension, alternating current to a "selector" board placed by the step-up transformers beneath the switchboard gallery. This board consists simply of a number of bare copper bars which can be connected together by switch fuses, so that any generator can be connected to the low-tension sides of either group of three transformers. There are two sets of three 100-kw Berry transformers, with no artificial cooling arrangements, and a third is to be added shortly. Both the primaries and secondaries of the transformers are mesh-connected, and each winding is protected by a fuse at each end, the low-tension fuses only being on the selector board. From the high-tension terminals of the transformers, cables are led directly to the high-tension switchboard on the gallery, passing through a roomy cable subway which runs parallel to the gallery. These cables are insulated with vulcanized rubber and braided, and are carried on brown earthenware shackle insulators. The subway is 6 ft. wide and 9 ft. high, so that there is plenty of room to pass through. The main feeders are also carried through the subway, being suspended on rounded cast-iron brackets fastened to the walls, and a tunnel extends right beneath the yard to a few feet beyond the main entrance to the works, so that it will be unnecessary to dig up the yard when laying additional feeders. The continuous current leads from the brushes of the generators are also insulated with vulcanized rubber.

They are led through ducts to the cable subway and thence are taken vertically to the low-tension panels of the switchboard.

Following out the 3,000-volt cables from the transformers, the six leads from the high-tension secondaries of each group of three transformers are taken to three panels of the switchboard, where they are connected in mesh on three Ferranti panels to the three high-tension

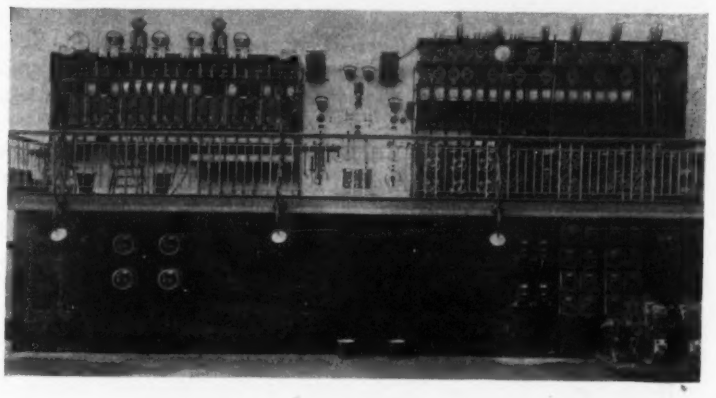


FIG. 4.—SWITCHBOARD GALLERY.

bus-bars. This board is of the ordinary Ferranti pattern, the only exception being that there are two fuses on each pole, both ends of each transformer winding being connected through a fuse. These fuses are of the oil-trough pattern; it is proposed to replace their porcelain covers with glass. The switches are of the oil pot pattern, the final break (which is a shunt to the main contacts) taking place under oil. The usual synchronizing current is provided, and in addition to the ordinary synchronizing arrangements an Everett-Edgecumbe rotary synchronizer is provided. The handles of each set of three switches are linked together in the usual way. The ammeter is in the main circuit on one phase only, the corresponding

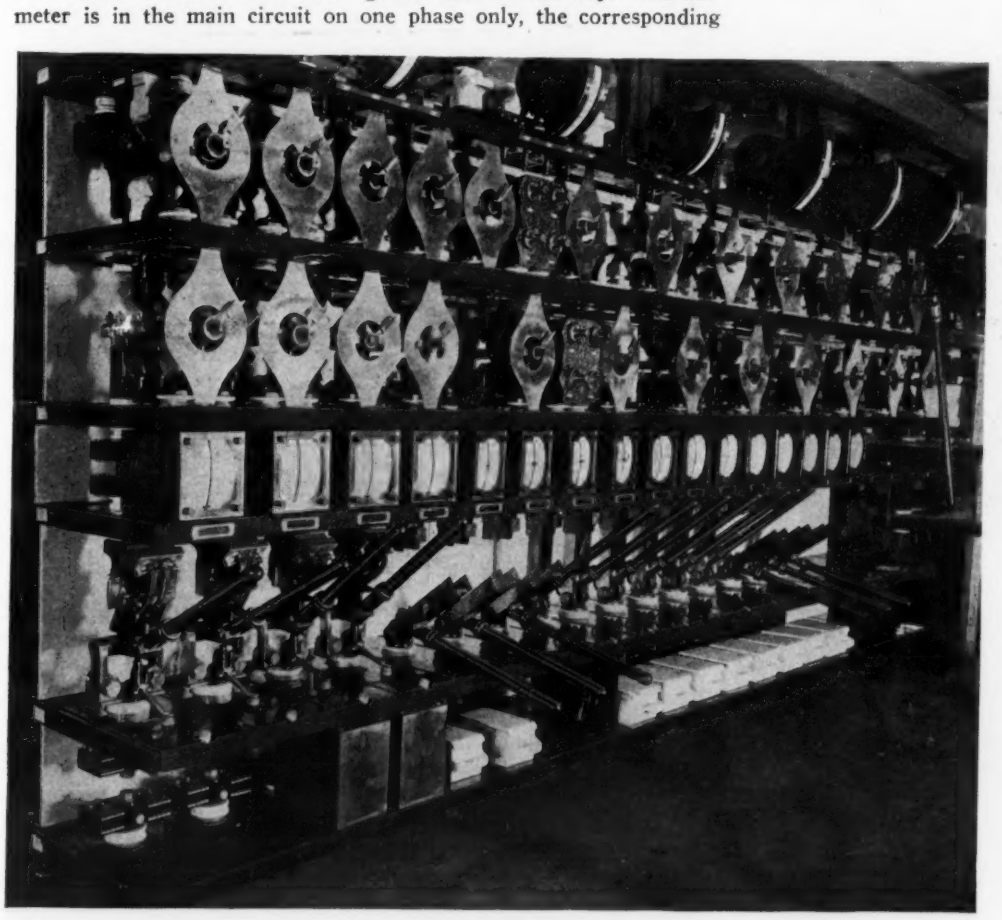


FIG. 5.—LOW-TENSION SWITCHBOARD.

cell of the switchboard on the other two are operated off the secondaries of a three-phase potential transformer having a ratio of 30:1. This transformer is of the three-limb type with common circular yoke and is complete with fuses. Placed in the base of this transformer is the neutral point resistance of the wattmeter. The wattmeter is scaled 0-700 kw, and reads the total load in the feeder, assuming that it is equal in each phase. The "wattless wattmeter" is scaled 700-0-700, and reads the total out-of-phase watts, assuming that the phases are equally loaded. The panels being taken up by a wattmeter and its star resistance and fuses. At present there are six panels on this part of the board, corresponding to two groups of three transformers, but there is space for considerable extension. There are no regulating panels on the high-tension board. As the generators supply both the alternating and continuous current from the same armature, it is evident that voltage regulation by varying the field excitation will have the same effect on the continuous-current and alternating-current sides. Hence, the regulation is done on the continuous-current board, in order that the 2 × 240-volt network supplied directly from the works shall always have a constant pressure. No regulation of the alternating current is necessary at the works, as variable-ratio transformers are used in the sub-station.

To the right of these panels are three sets of high-tension feeder panels similar to those already described except as regards the instruments. There is a single ammeter as before, but this is not in the main circuit, but connected to an instrument transformer (placed below the gallery), and on the two panels corresponding to the other two phases there is a wattmeter and a "wattless wattmeter," both by Messrs. Elliott Bros. and both connected to transformers below. The diagram of connections for these instruments is given in Fig. 8, from which it is seen that the ammeter and the current circuits of the wattmeter and "wattless wattmeter" are connected in series and operate off the secondary of a current transformer, the primary of which is connected in one of the line wires of the three-phase circuit. This current transformer is made to fit into the contact jaws usually used for the Ferranti ammeter, and is mounted in one of the pockets behind the instrument. The volt circuits of the wattmeter and "wattless wattmeter" ratio of the readings of the

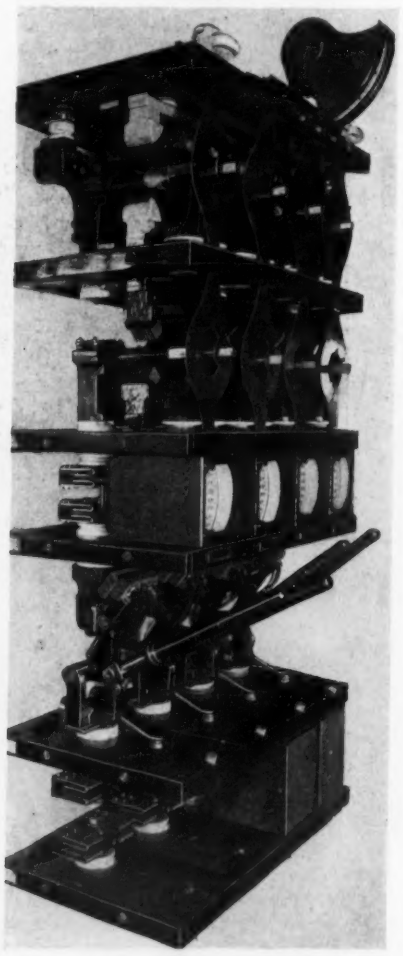


FIG. 6.—FOUR-GENERATOR PANELS.

two instruments gives *tan* ϕ, and, therefore, by reference to a curve the power factor of the circuit. With a leading current the "wattless" instrument is, therefore, used in connection with the rotary converters, the excitation of which can be altered until the reading of the instrument is zero. All the instruments are of the dynamometer type, spring controlled and magnetically damped, and are not affected by wave form or frequency. They are interchangeable mechanically

and electrically; that is to say, any of the instruments can be connected in series to form a set and put to operate off either of the current and potential transformers and will still read accurately.

From the bus-bars connection is made through two three-phase meters in series to the feeder cables in the subway. The meters are for measuring the "bulk" supply, the two in series being merely in order that the readings may be checked. They are placed on a meter board immediately below the switchboard on the floor of the engine room.

Between the high-tension board and the low-tension board there is a space which is temporarily occupied by a panel for the "inverted rotaries." The Willesden station, in addition to lighting Willesden, has now to supplement the supply derived from the Brimsdown station for the North Metropolitan tramways. The tramway sub-station which the Willesden station feeds is at Hendon, and an extra high-tension supply (10,000 volts) has been chosen, with a frequency of 50 cycles per second instead of 25 cycles, which is the frequency at the Taylor's lane works, the higher frequency being in order that the tramway rotary converters on the system should all be similar. The frequency of 25 cycles was adopted for Willesden long before there was any question of the works being acquired by the company. Two of these machines have been erected, taking

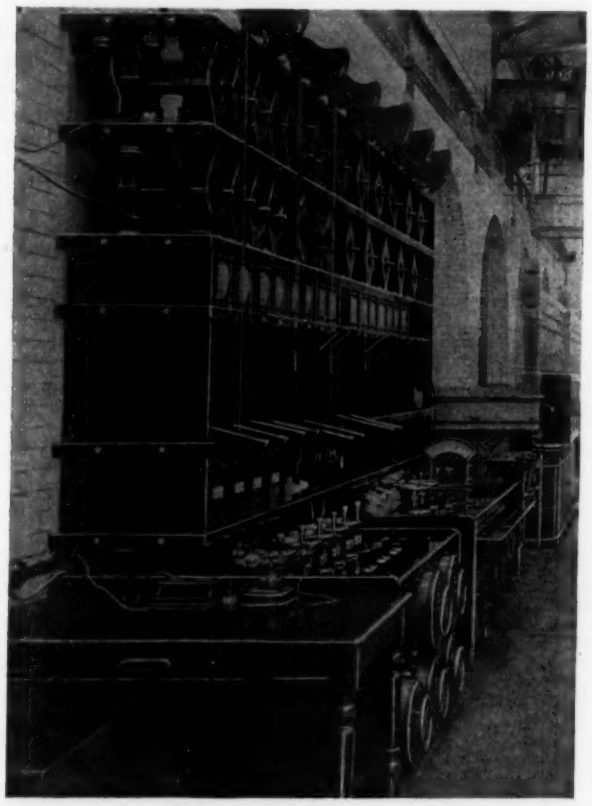


FIG. 7.—LOW-TENSION SWITCHBOARD.

continuous current at 500 volts from the continuous-current bus-bars and delivering alternating current at 50 cycles directly to step-up transformers. The extra high-tension feeders to Hendon are connected directly to the secondary terminals of these transformers, there being no switches, fuses or excess pressure dischargers on the alternating-current side. The omission of mains dischargers, which, we understand, was at the desire of the cable makers and with the consent of the transformer makers, is surprising, as the machines are run up on the mains, a process which, as is now known, conduces to surgings of excessive pressure due to resonance effects. The rotary converters (which are of the British Thomson-Houston make) are each rated at 250 kw, and each is provided with an independent exciter, so that the frequency does not vary with every change of the bus-bar pressure.

Each converting set is considered as a complete unit in itself, feeding an exact duplicate set located in the Hendon sub-station. Each set feeds through a separate feeder, but at the Hendon end provision is made by means of sectionalizing switches so that either rotary can be fed through either feeder, which arrangement insures a continuation of the supply in the event of an accident occurring on any one feeder. When the scheme is completed and additional three-phase generating sets at 50 cycles have been installed in the Willesden generating station, it will only be necessary to connect these to the existing Hendon sub-station feeders in place of the temporary inverted rotaries, which will then be released for work in some other sub-station.

Each rotary runs at a speed of 750 r.p.m., and is flat compound-wound for 550 volts. The exciters are belted to the rotaries, and operate at a low point on the saturation curve, thus making the sets sensitive to any speed variation. The exciters themselves are so designed that they may be converted into series-wound track boosters at a later date. The stationary transformers are of the single-phase, oil-cooled type, and call for no special mention. They are connected in mesh.

For starting the shunt coils the rotaries are first excited from the continuous-current bus-bars in the ordinary way, and when all the starting resistance has been cut out and the rotaries are up to speed, the field resistance of the exciter is varied until the exciter voltmeter shows a voltage equal to the bus-bar pressure. The exciter is then switched in, and the connection between the field of the rotary and the bus-bars is broken. In order to prevent excessive speeds in the rotaries at the two ends in the case of the exciter fields being diminished, an excess speed contact-maker (actuated by centrifugal force) is placed on the shaft of the rotary and actuates a tripping coil on the circuit-breaker between the bus-bars and the rotary armature. This circuit-breaker has also a useful "tell-tale" contact, which closes a bell circuit when the cut-out drops. As the circuit-breaker serves also as the main switch on one pole, it is necessary to provide means to switch off the bell circuit when the circuit-breaker has dropped; this has to be done by turning the contact piece which it carries, but on replacing the circuit-breaker to switch in again this contact is automatically set to its original position.

For the general arrangement, and for the design of many of the

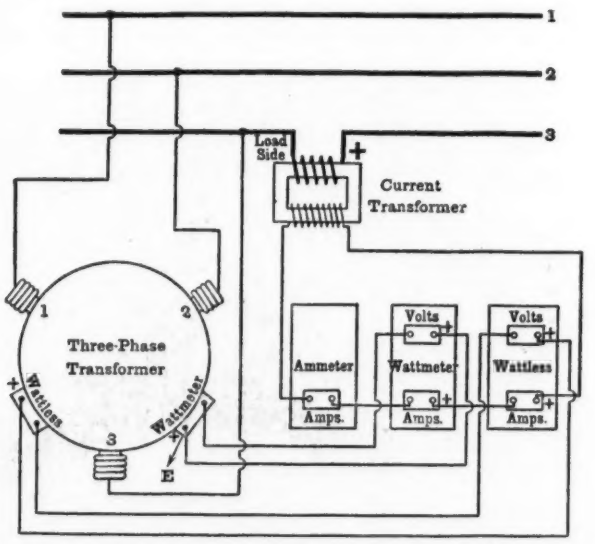


FIG. 8.—CONNECTIONS OF INSTRUMENTS ON HIGH-TENSION FEEDER PANELS.

special details of the low-tension, continuous-current switchboard, Mr. Ruthven-Murray was responsible. His object was to arrange a switchboard embodying the distinctive and valuable features of the Ferranti high-pressure cellular type of switch gear for low-pressure working. The principal feature of novelty in the low-tension switchboard is that four separate bus-bars are provided, and there are "selector switches" which enable any machine or feeder to be connected to any bus-bar. This makes it possible to have four different feeder pressures, and the arrangements are so simple that no complication is introduced on the switchboard at all, the only effect being a slight increase in height. This is unimportant, for the selector switches are only moved occasionally and can, therefore, be placed high up. This addition to the Ferranti board was patented by Mr. Ruthven-Murray. Figs. 5 and 6 show the selector switches clearly in position; they are turned by a long handle fitting over the square end of the spindle. Fig. 9 is a drawing showing the details of the switch.

The selector switches are, of course, placed on each pole, but the main switch and edgewise ammeter are on the positive pole only. The main switches have each an excess current tripping coil, placed in the cubicle beneath the switch itself. In front of the generator panels is the field regulating switch, externally of the Ferranti desk

pattern, and internally of the Westinghouse manufacture. In addition to this a field switch is provided which switches the field coils of the machines on to the brushes for self-exciting or to exciter bars in case separate exciting is subsequently found necessary. Two plug holes are provided on the field board for plugging in a voltmeter in front of the field ammeters when paralleling, a portable differential zero voltmeter with plugs being provided for the purpose.

The four-plug switches taking the place of the selector switches on the sixth and seventh panels are for connecting the four bus-bars in parallel if desired. One is for the positive bars and the other for the negative. Three voltmeters are seen at the top of the board, each so arranged that it can be pulled by cords to any one of four positions. These voltmeters show the voltage across the outers and on each side of the network, respectively, and they can be placed across any of the four sets of bus-bars, as the rails they run on make the necessary contacts. The four panels on the extreme right are for the feeders, and they are similar to the generator panels, with selector switches on both poles and a main switch on one pole. The tripping coil is replaced by a fuse, however. One of the voltmeters above them is connected to any pair of pilot wires from the feeding points by means of an eight-point switch. There is space for a considerable number of additional feeders.

The fifth and sixth panels from the left are the panels for the positive and negative balancers, only one selector switch being needed for each of these. The ammeters on these panels are central zero

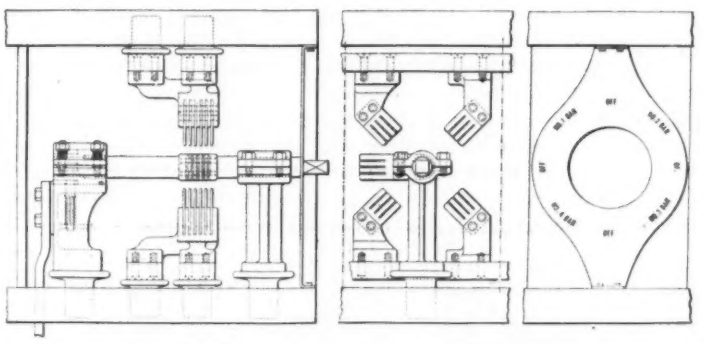


FIG. 9.—SELECTOR SWITCH.

instruments. These panels have fuses in place of the excess current tripping coils. Next come two battery panels similar to the balancer panels, but with the addition of a change-over switch enabling the position of the two halves of the battery on each side of the neutral bar to be changed, or else to be connected in series across the outers and disconnected from the neutral bar. Two plug holes similar to those on the exciting panel for paralleling the generators are provided, so that a voltmeter can be placed in them to parallel the batteries with the bus-bars.

The boosters and balancers are combined on the same shaft. This has three bearings, and the balancer commutators are to the inside facing the central bearing, the booster commutators being outside. Each booster can raise or lower the pressure by 167 volts, and the balancers can deal with 84 amp. of out-of-balance current. The balancer fields are cross-connected as usual, but the booster fields are also cross-connected, so that, although not "automatic" boosters, there is a certain amount of automatic pressure regulation. A switch enables the field of either of the boosters to be reversed, so that the machines can be discharged through and boost the voltage from the batteries up or down; or they may be used to boost up from one pair of bus-bars to another, so as to supply any particular feeder at higher or lower pressure than the others. No regulating cells are provided, the regulation being effected entirely by the boosters both on charge and discharge. The switches for this are in front of the main board in a line with the generator field regulating board. There are two central zero voltmeters for the boosters above the board. The starting switch for the booster balancer set is at the end of the switchboard, and independent. All the instruments on the low-tension board were supplied by the well-known firm, Nalder Bros. & Thompson, of London, as sub-contractors to Messrs. Ferranti.

The battery room contains 250 Tudor cells with a capacity of 840 amp.-hours at a 10-hour discharge rate. The cells are placed in pairs on racks of the usual pattern. As has already been mentioned, there are no regulating cells, but a few extra cells are provided as spare and for "milking" purposes.

The Electrical Equipment of the Karawanken Tunnel.

AN interesting electrical power transmission plant and equipment has been utilized in Austria-Hungary for the construction of the Karawanken tunnel. The Karawanken tunnel begins at Rosenbachthal, South Velden, on the Worthersee. The south end of the tunnel is located at Birnbaum, on the State Railroad, in the valley of Wurzener Save. The construction of the tunnel was started at both ends and met in the center at a height of 630 meters above the sea level. The fall to the south was 6 per cent., while the grade to the north was 3 per cent. In the construction of this tunnel there were 1,700 workmen at the north end, 1,100 of whom worked in the tunnel itself, while on the south side there were 2,200 workmen, 1,200 working in the tunnel, which was constructed with a minimum height of 3 meters, and a minimum width of 2.50 meters.

To supply the necessary power an electrical power transmission plant was installed at Rothweinbaches, a distance of 6 miles from the south tunnel portal, and another at Rosenbach, a distance of 1¼ miles from the northern tunnel portal. The line voltage is 5,000. The water power available at Rothweinbach was equivalent to 900 hp, with a fall of 28.4 meters and a discharge rate of 3 cubic meters per second. The power house at Rothweinbach was equipped with three turbines of 450 hp each, a three-phase alternator of 400 kw capacity being directly coupled to each turbine, the speed being 750 r.p.m. Two of these three electrical generators were usually employed, the third being held in reserve. These machines supplied three-phase currents with a frequency of 50 periods per second and a pressure of 550 volts. The turbine wheels at this plant are equipped with automatic regulators, which control the speed very accurately. The switchboard consists of three marble panels for the measuring instruments regulating apparatus and switches, which control the high-tension, three-phase power transmission line which connects the power house with the tunnel entrance. Highly insulated iron-armored cables are used within the tunnel.

The construction of this power house was extremely difficult on account of the trouble of transporting the building material and machines to the site of the plant and a new bridge had to be constructed for aiding in the work of transportation. The hydraulic installation was undertaken by Madile & Co., of Klagenfurt, the mechanical equipment being installed by the Maschinenfabrik Andritz Aktiengesellschaft, of Andritz, and the electrical equipment by Siemens & Halske, of Vienna. The power transmission line con-

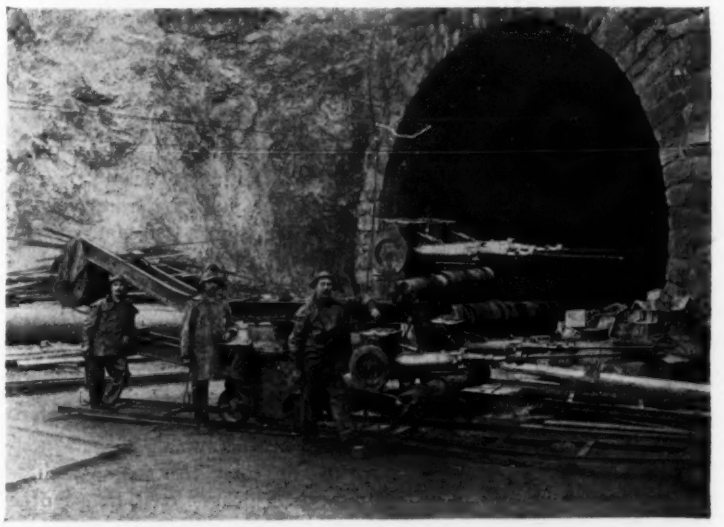


FIG. 1.—DRILLING RIG IN FRONT OF TUNNEL ENTRANCE.

sisted of three bare copper wires each 8 mm. in diameter. The total length of the high-tension power transmission line is about 6 miles, which includes an underground section of armored high-tension cable of the three-phase type having a copper section of 3 x 50 mm.². The entire loss on the transmission line is from the central station to the tunnel—10 per cent.

The ventilator plant of the Karawanken tunnel is supplied with current from the Rothweinbach power house and consists of two groups with three centrifugal ventilators in each group. Each group of three ventilators is directly coupled to a high-tension, three-phase, alternating-current motor of 180 hp capacity. At a speed of 1,450

r.p.m. the ventilators supply 350 cubic meters per minute to the tunnel, making the atmosphere therein extremely satisfactory for the workmen. These motors may be operated with short-circuited windings and also with slip rings and brushes.

Each of the two motors with its group of three ventilators is operated for three days of 24 hours each and at times for a longer period, after which the second group is placed in circuit while the first group is inspected. The ventilating pipe is 600 mm. in diameter, a water-cooling system being provided so that the air forced into the tunnel in summer is of a moderate temperature.

The electric railway and locomotives for the tunnel were supplied by Siemens & Halske and the Maschinenfabrik Andritz Aktien-

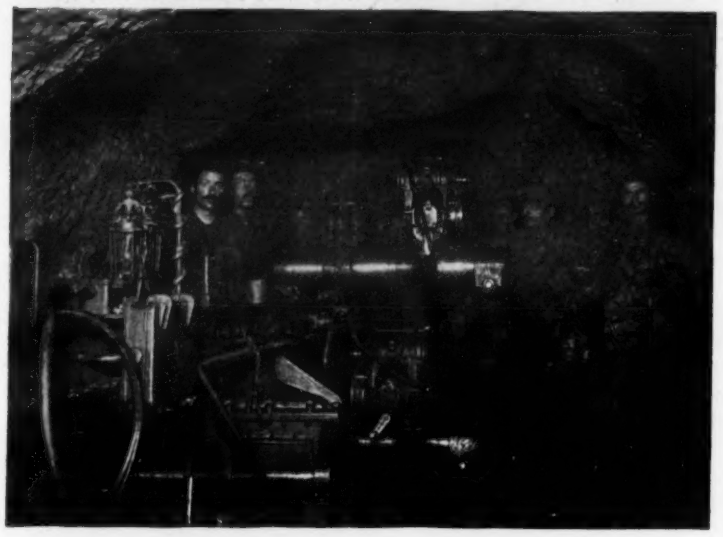


FIG. 2.—DRILLING RIG AT THE WORKING SPOT.

gesellschäft. These electric locomotives are required to handle six loaded cars of material, each weighing 4.2 tons, or together 25.2 tons, the smallest curve having a radius of 75 meters. Or they are required to handle a train of 15 empty cars each weighing 1.2 tons, or together 18 tons, with the same minimum curve. The maximum drawbar pull of the locomotive is 2,900 kg. Two of these electric locomotives are coupled together forming a double locomotive with single control. Each axle is connected to a direct-current railway motor of 25 hp capacity. The normal speed of these locomotives is 10 km. per hour. Three of the double electric locomotives were operated on the south side of the tunnel, the total length of the trips being 7.5 km.

The current for operating the electric locomotives was supplied from a sub-station which was connected with the Rockweinbach power station transmission line and equipped with step-down transformers and a 250-kw rotary converter. The sub-station received current from the transmission line at 5,000 volts and two stationary step-down transformers of 230 kw each were provided for lowering the pressure to 350 volts, which the rotary raised to 560 volts direct current. The rotary converter has eight poles and operated at a speed of 750 r.p.m. It is provided with a six-pole asynchronous motor of small size for driving the rotary up to synchronizing speed.

The electric railway overhead working line consists of a bare copper wire of 80 mm. cross-section. The loss of pressure was about 10 per cent. at the greatest distance from the sub-station.

The outside lighting is supplied by 26 arc lamps of 1,500 cp each, while the inside lighting is provided by 618 incandescent lamps of 16 cp each. The lighting current is supplied from transformers of 60 kw capacity, the pressure being 190 volts for the arc lamps and 110 volts for the incandescent lamps.

The Rothweinbach central power station also supplies current for operating two electrically driven compressors, each requiring 200 hp, and as a workshop in the same building, the total power used being 438 hp. The air compressors each supply 25 cubic meters of air per minute at a pressure of 7 atmospheres for operating six pneumatic boring machines. The ventilating plant and the power station as well as other points are connected with a telephone system, the conductors used being 1.5 mm. in diameter and mounted on the high-pressure transmission line poles 2 meters below the power conductors. The total length of the telephone conductors is 40,000 meters.

The power station on the north side of the Karawanken tunnel, located at Rosenbach, takes water from the Drau River, a small stream, which supplies a minimum of 600 liters per second and a normal supply of 1,000 liters of water per second under a head of 72 meters. The water pipe is of wrought iron, 800 mm. in diameter and 1,850 meters long. This plant is supplied with three turbines of 300 hp each, operating at a speed of 500 r.p.m., with a water consumption of 510 liters per second under a head of 58 meters. Each of these turbines is directly coupled to a three-phase alternator constructed by the Oesterreichischen Schuckert Werke, with a capacity of 270 kw as a maximum load or an output of 216 kw with a power factor of .8 and a pressure of 5,200 volts. This central station is connected by a transmission line 2,300 meters long to the electric ventilator plant at the north tunnel entrance. This transmission line consists of three bare copper wires each 5 mm. in diameter mounted on high-tension insulators on wooden poles. This ventilator plant includes two three-phase motors of 180 hp capacity constructed by the Oesterreichischen Schuckert Werke, directly coupled to two groups of three ventilators each similar to those at the south side of the tunnel, supplying 350 cubic meters of air when operating at a speed of 1,450 r.p.m. The double electric locomotive and electric railway equipment as well as the lighting installation and telephone systems at this side of the tunnel are very similar to those of the south side.

An interesting feature connected with the construction of the Karawanken tunnel is the use of electric boring machines. These are each equipped with four motors of 43 hp capacity, together with transformers on each machine, the boring tools each being provided with 2-hp motors operating the drills as indicated in the illustrations. The electric boring machines consist of a car provided with a cable drum and several electric drills mounted on the adjustable frame. Both direct-current and alternating-current motors have been utilized in the operation of these machines.

The 5,000-volt, three-phase current from the high-tension power transmission line is conducted through a three-conductor, iron-ar-

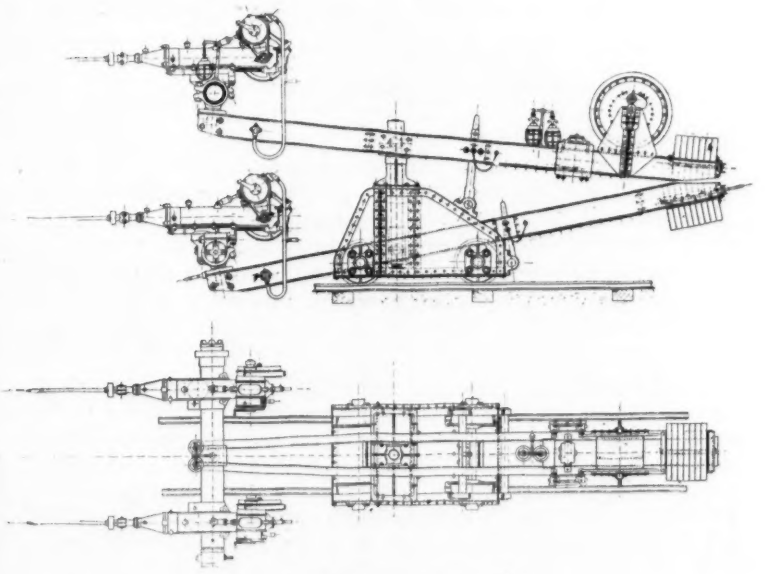


FIG. 3.—ELECTRIC BORING MACHINE.

mored, high-tension cable of 3 x 6 mm.² copper cross section to a transformer of 25 kw capacity, which is used for transforming the pressure to 250 volts. The low-pressure cables are also iron-armored and lead-covered, with three conductors each of 35 mm.² cross section. These cables connect with the boring machines, which are provided with drums holding about 200 ft. of cable.

The total length of tunnel completed at the north end of the Wocheiner tunnel, where electric boring machines are employed was 2,733 meters, and the total length of tunnel completed on December 5, 1903, at the north end of the Karawanken tunnel was 2,810 meters, an electric boring machine being also used there. On the same date at the south end of the Karawanken tunnel only 1,946 meters were completed, using pneumatic boring machines of the Schwartz type. Since that date a great deal of work has been accomplished toward the completion of the Karawanken tunnel and much credit is due to the engineers designing the electrical equipment for this work.

The electric boring machines constructed by the Oesterreichischen Siemens-Schuckert Werke, now in operation at the north side of this tunnel, excavated during April, May and June, 1904, 177 meters, 154 meters and 165 meters, respectively, and for January, February and March, 1904, 167 meters, 147 meters and 192 meters, respectively. The size of the tunnel is 2.5 meters by 3 meters in cross section.

Details of the Westinghouse Single-Phase Electric Railway System.

The single-phase electric railway system invented by Mr. B. G. Lamme has been the subject of several articles in these columns describing it in a general way, and we are now enabled to give an account of some of its more important details. It will be recalled that the system was first announced in a paper read before the American Institute, in September, 1902, but prior to that year a long series of tests at the Westinghouse shops had demonstrated the value of the series alternating-current motor. In addition to these a number of 40-hp motors of this type had been operated continuously for nine months in a manufacturing plant. Since that time the Westinghouse engineers have been actively engaged in perfecting the details of the other apparatus required to complete the system. For nearly two years a car equipped with these motors has been in almost daily use upon the inter-works railway between East Pittsburg and Wilmerding, and systems of regulation and control suited to various operating conditions have been devised.

Referring to Fig. 1, there are three electric circuits upon each car, as follows:

1. The motor circuit. In this circuit there are placed the circuit-breaker, main transformer, induction regulator, reverser, motor cut-out switches and motors.

2. The auxiliary control circuit. An electropneumatic system of control is used, the various parts being operated by compressed air controlled by magnet valves. Current for the magnet valves is obtained from a 14-volt storage battery placed under the seat of the car. The use of a separate low-voltage circuit for this service is a valuable factor of safety. The fact that the control circuit is independent of the line and can be used whether the trolley is in use or not is also an advantage.

3. The lighting and heating circuit. This contains the necessary apparatus for lighting and heating the car and also the air compressor motor with its governor. It is taken from the line by a second transformer. This circuit is not connected with the motor circuit.

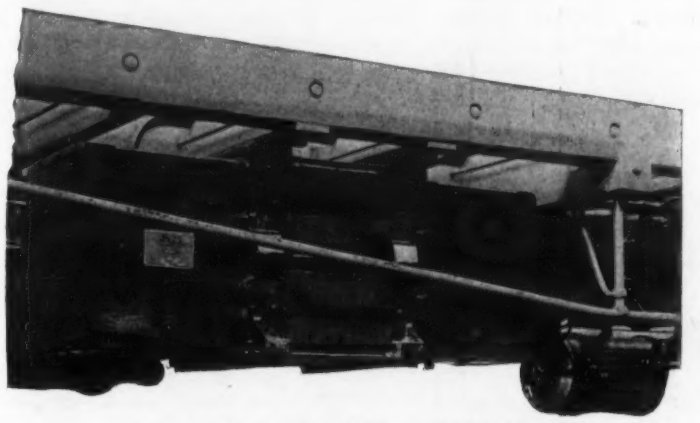


FIG. 2.—AUTO-TRANSFORMER IN MOTOR CIRCUIT.

The motor circuit begins with an auto-transformer of special design connected between the trolley wire and the ground. This transformer is so arranged that the current of air created by the motion of the car circulates through it, thus keeping it cool. A view of this transformer as mounted beneath a car may be seen in Fig. 2. At a point approximately 230 volts from the ground a circuit is led from this auto-transformer through the secondary of the induction regulator, and another tap, approximately 650 volts from the ground, is led through the primary of the regulator. The exact wiring of this arrangement may be seen in Fig. 1 and the diagrammatic arrangement in Fig. 3, which is somewhat modified for greater clearness.

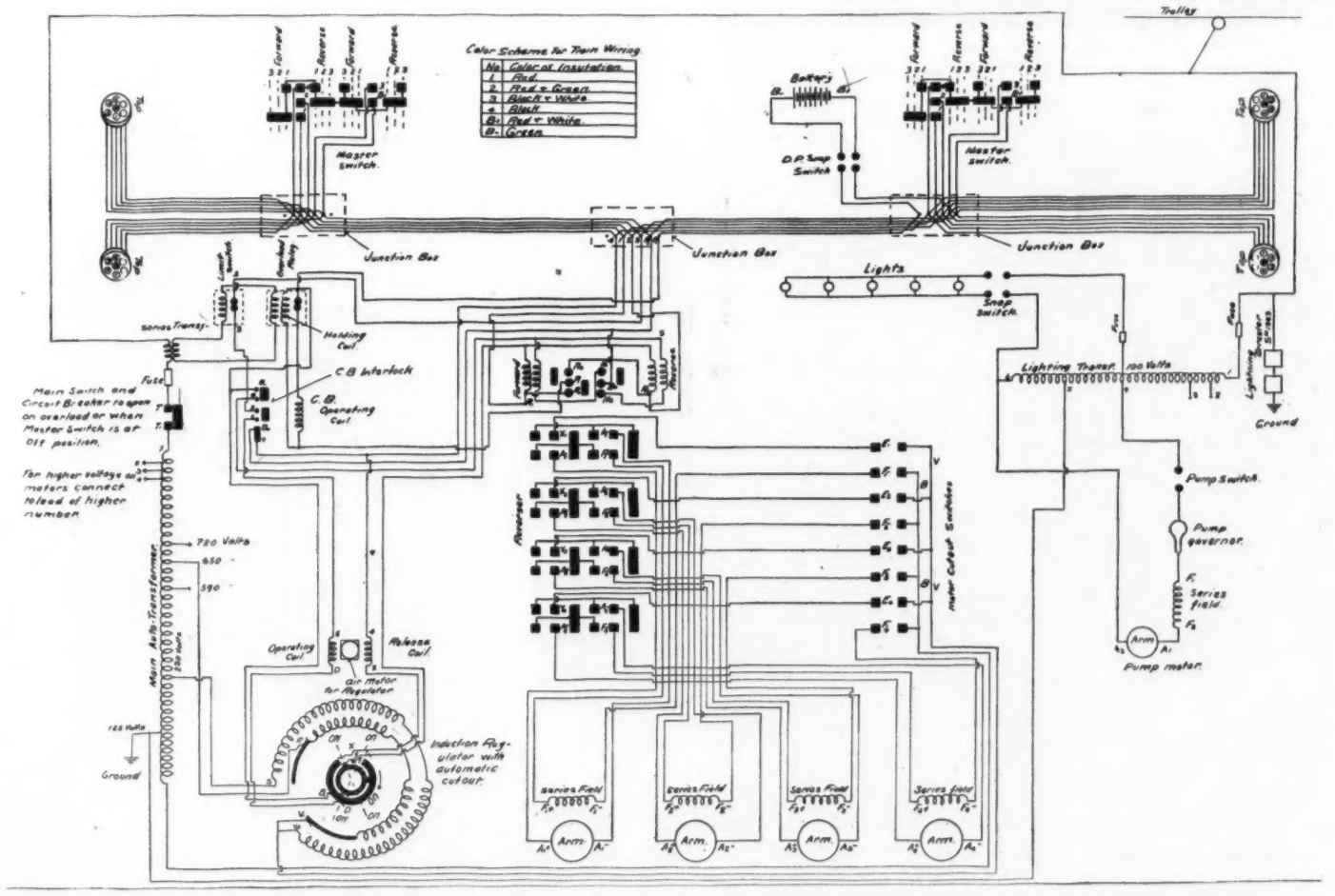


FIG. 1.—WIRING DIAGRAM OF CAR EQUIPMENT.

Between the auto-transformer and the trolley is placed the circuit-breaker (Fig. 4), which also acts as a main switch and not only automatically opens the circuit when an overload occurs, but also whenever it is desired to cut off the current from the car. This circuit-breaker is held in place by a compressed air cylinder working against a powerful spring. When the air is allowed to escape the spring opens the breaker. The admission or release of air from the pneumatic cylinder is controlled by means of magnetic valves.

The voltage applied to the motors and consequently the speed of

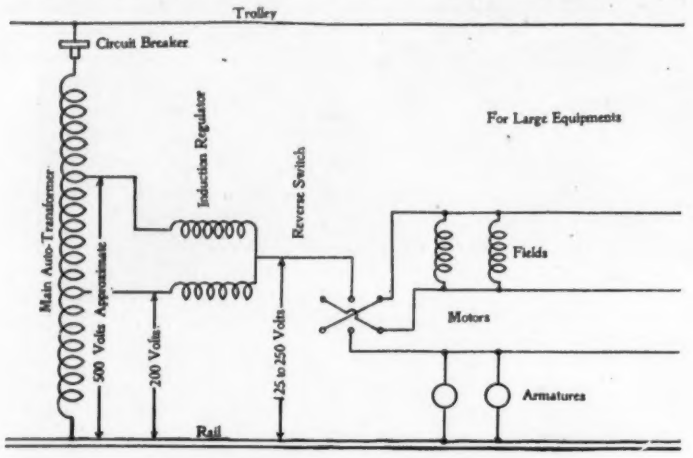


FIG. 3.—DIAGRAM OF MOTOR CIRCUIT.

the car is governed by the induction regulator. This is in effect a transformer with its primary core and winding movable with respect to the secondary. It is operated by means of a small pneumatic motor controlled by electromagnetic valves and may be turned so that its voltage either opposes or aids that of the auto-transformer any amount within the capacity of the regulator. In the "off" position the full voltage of the regulator is opposed to the 230-volt circuit of the auto-transformer, thus giving a low voltage for starting the motors. At the "full-on" position the entire voltage of the regulator is added to that of the 230-volt circuit of the auto-transformer, giving the proper voltage for full speed running. The regulator can be left indefinitely in either of these or in any intermediate position, and thus the car can be run at any desired speed. A diagram of the regulator circuit is shown in Fig. 5.

The reverser, as its name implies, changes the connections of the motor armatures with reference to their fields, so that the car may be run either forward or backward. The reverser is operated by means of two pneumatic cylinders, one throwing it forward and the other backward. Air is admitted to either cylinder when desired by means of a magnetic valve.

The motor cut-out switches consist of a double-pole switch for each motor, all mounted together and enclosed in a suitable iron case. In case of damage to any motor, the injured motor can be cut off entirely from the circuit, and the car then operated with the remaining motors.

The motors are permanently connected in parallel, the advantages ordinarily derived from a series parallel arrangement being obtained directly through the use of different positions of the induction regulator, without changing the connections of the motors with respect to each other. As the motor voltage is independent of the trolley voltage, a standard of 250 volts has been adopted, irrespective of the voltage of the trolley.

The operation of the various magnet valves which regulate the movement of each of the above pieces of apparatus is controlled by means of a master switch located on the platform of the car. A view of this switch, together with the motorman's air brake valve, may be seen in Fig. 6. There are but three positions for the handle of the master switch for operating the car in a forward direction, and three corresponding positions for backing. When the handle is turned to the first notch on either side connection is made with

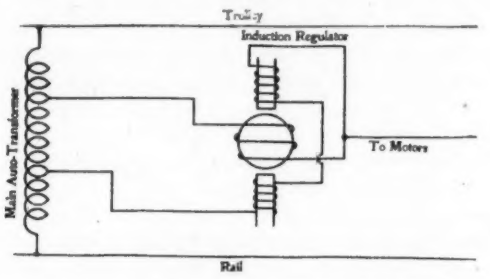


FIG. 5.—INDUCTION REGULATOR CONNECTIONS.

the magnetic valves governing the reverse switch. Air is admitted to the proper cylinder and the reverser thrown to the proper position. When the reverse switch has been operated air is then admitted to the pneumatic cylinder of the circuit-breaker and the circuit-breaker is then closed. This applies current to the motors and the car starts.

To secure a higher speed, the handle is thrown to the third notch, which closes the circuit to one of the magnet valves controlling the pneumatic motor which drives the induction regulator and air is thus admitted to the air motor. The regulator is then turned, gradually raising the voltage at the terminals of the motors. If the handle of the master switch is left on the third position, the regulator will advance to the "full-on" position, where it will be automatically stopped. If it is desired to operate the car at anything less than full speed, the handle of the master switch may be brought back to the second position and the regulator will at once stop and remain stationary. Under such circumstances, if the handle is again moved to the third position, the regulator will advance and increase the voltage at the motors and consequently the speed of the car. If the handle is moved back to the first position the regulator will return toward the minimum position, lowering the voltage on the motors, thus lowering the speed of the car. If at any time it is desired to cut off the current, the handle of the master switch may be returned to the "off" position, in which case the circuit-breaker will open at once, thus cutting off the current imme-

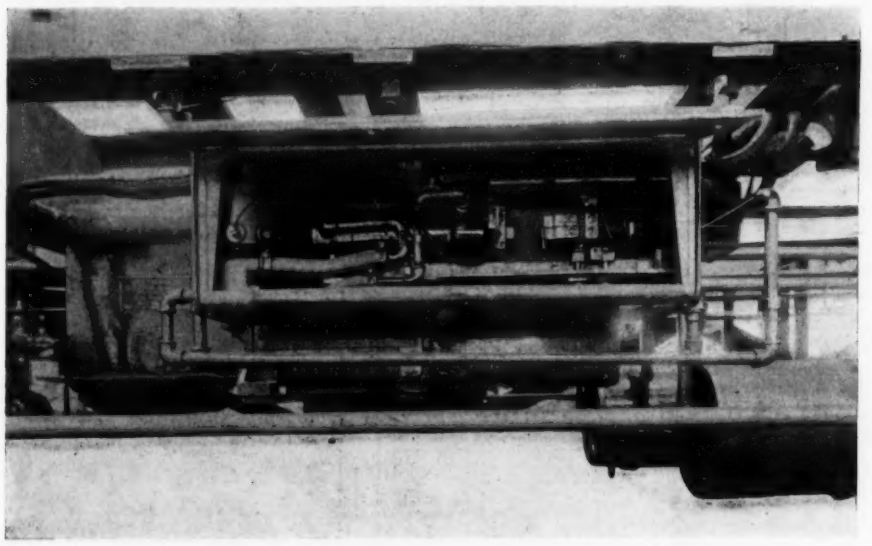


FIG. 4.—CIRCUIT-BREAKER AND AUTO-TRANSFORMER.

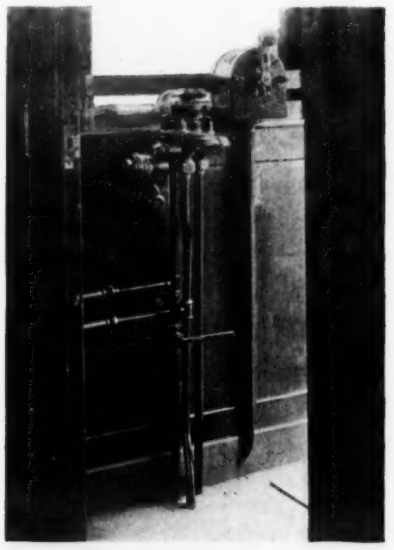


FIG. 6.—CONTROL APPARATUS IN CAB.

diately. After the circuit-breaker has been opened the regulator will return toward the minimum position and the circuit-breaker having once been opened cannot be closed again until the regulator has reached the position of minimum voltage.

The circuits leading to the circuit-breaker and reverser are so interconnected that the circuit-breaker cannot be closed until the reverser has first been thrown, nor can the reverser be moved unless the circuit-breaker is open.

The arrangement described can be adopted for multiple control by the addition of leads, connection boxes and "jumpers" for forming a continuous-control circuit over the different cars, no other change being necessary.

The advantages of this method of speed control, as compared with rheostatic control, are evident. The elimination of resistance losses,

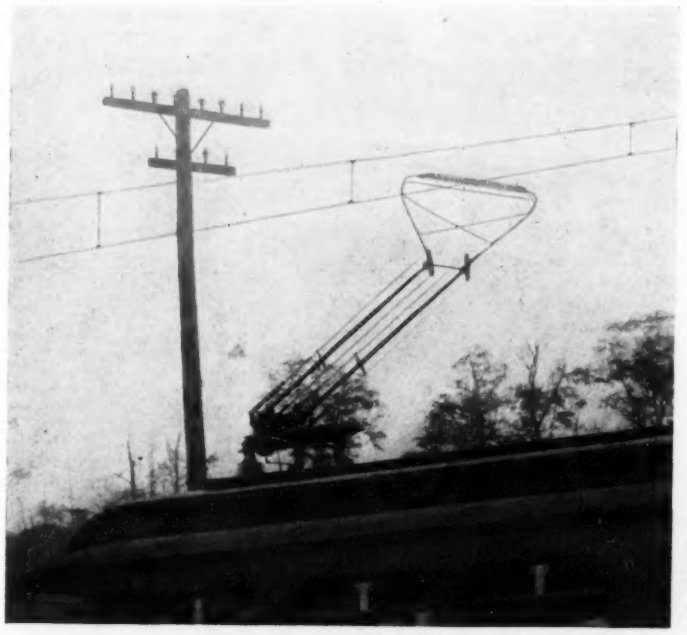


FIG. 7.—BOW TROLLEY MOUNTED FOR SERVICE.

the ability to change speeds without opening the circuit, the fact that every speed may be used for continuous running and the ease and flexibility of control are important benefits thus derived.

The lighting and heating circuit is operated from a small auto-transformer similar in design to the one in the motor circuit. From this transformer are supplied the lights in the car, the heating circuits—if any—and the small motor for operating the air compressor. The latter may be controlled by an automatic governor or by the hand switches which are conveniently located.

Where the voltage of the line is 1,000 or less, connection between the car and the trolley wire is established by means of a trolley of the ordinary type. For higher voltages, a trolley of the bow type, especially designed for the purpose, is used. This is raised and lowered by compressed air under the control of the motorman and any danger from shock in handling is thus avoided. In Fig. 7 it is shown in the running position. The two levers at each side are so arranged that when the pneumatic pressure is removed the trolley lies flat upon the top of the car. When the air is applied, the result is first to raise the upper section at about the angle illustrated, and then to lift the entire trolley to the running position. The main spring keeps the trolley upright, but permits it to give under pressure. When the direction of the car is reversed the upper portion of the trolley is slanted in the opposite direction. The side springs in the levers, which support the upper portion of the trolley, adjust it for variations in the height of the wire, and the trolley is thus kept in contact with it and a continuous unbroken current results. With ordinary variations the position of the lower portion of the trolley remains unchanged, the fluctuations affecting only the lighter upper section and insuring a sensitive action. The chief advantages given by the trolley are the substitution of pneumatic for hand control, with the consequent elimination of all danger from grounding through the hand rope; a continuous contact with the trolley wire and the impossibility of the trolley slipping off the wire and damaging the overhead structure.

At each support the trolley wire is attached at a point alternately twelve inches to right and left of the center of the track, so that it is staggered, and the contact between it and the trolley varies from one side to the other and thus under wear at any point is prevented.

The overhead structure, which is of the catenary type, is shown in Fig. 7. The trolley wire is suspended from a messenger cable by hangers of different lengths, so graduated that the wire is at all points parallel with the track, presenting the best possible condition for continuous contact under high speeds. This construction also gives a greater rigidity, with the absence of up-and-down or side-wise motion, an increased strength and consequent ability to support loads of ice in winter storms, and strength and simplicity in all parts that minimize repairs and, in general, an efficiency in keeping with other portions of the system. This catenary structure can be suspended from side brackets as shown, or the ordinary span construction can be adopted. Grooved trolley wire is used, and since it is supported at frequent intervals, great rigidity can be obtained with a small size of wire. Suitable details of construction for use upon curves of different radius, of anchors, steady strains, section breaks, turn-outs, etc., have also been carefully designed.

The Power Plant of the Lewis Publishing Company, St. Louis, and the Largest Searchlight in the World.

THE attention bestowed upon a power plant by the engineering world at the present time is largely governed by its size and capacity. While the larger plants usually embody more that is new and deserving of attention, there are at times constructed power plants of very small capacity which, through the work they are called upon to perform, or because of some underlying ideas in their construction, are worthy of notice. The power plant of the Lewis Publishing Company, near the World's Fair grounds at St. Louis, has many features which are seldom encountered.

The Lewis Publishing Company in itself is a remarkable insti-

FIG. 1.—OFFICE BUILDING WITH SEARCHLIGHT ON DOME.

tution. It is the outgrowth of a company formed five years ago to publish *The Woman's Magazine*. The paper at the present time has more than 1,500,000 subscribers, and the printing and publication for these and an additional 500,000 copies of *The Woman's Farm Journal* necessitated the erection of the new plant on the outskirts of St. Louis, near the Exposition grounds.

The electric plant supplies current for the two main buildings. One of these, the office building, upon which is mounted the largest searchlight in the world, is shown in an accompanying engraving.

The other, located to the rear and connected to the office building by an underground tunnel, contains the pressroom.

The power plant is contained in an addition to the rear of the pressroom. Both the engine and boilerroom floors are placed about 10 ft. below the floor carrying the presses. The engineroom occupies the western end of this rear addition and between this and the boilerroom in the eastern end is space for the storage of coal. The two boilers, which are of a rather unusual type, may be seen in the accompanying reproduction from a photograph. They were built by the Hamler Boiler & Tank Company, of Chicago, Ill. They are well covered with lagging, as is all the piping in the engine and boilerroom. Induced draft created by a fan, above the boilers, eliminates the necessity of a high smokestack. The low chimney through which the fan discharges may be seen in the view of the exterior of the

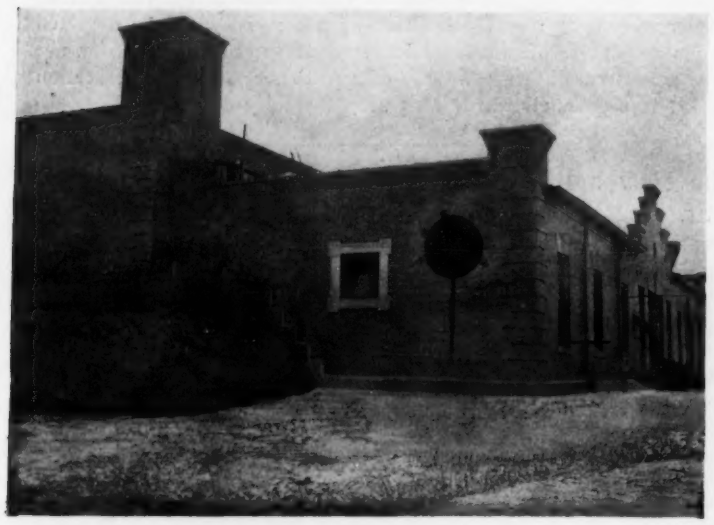


FIG. 2.—EXTERIOR OF POWER HOUSE.

boilerroom. This rises but a few feet above the wall of the building. The exterior view also shows the motor-driven ventilating fan, with which the boilerroom is supplied.

Coal is unloaded from wagons into a hopper, from which it falls to the storage space immediately in front of the boilers. Ashes are removed from the boilerroom by means of an ash conveyor. The chute through which they are discharged may be seen in the exterior view of the power house. As has been previously stated, the engineroom occupies the western end of the rear extension to the pressroom. The room is small, but neat. The upper portion of the walls

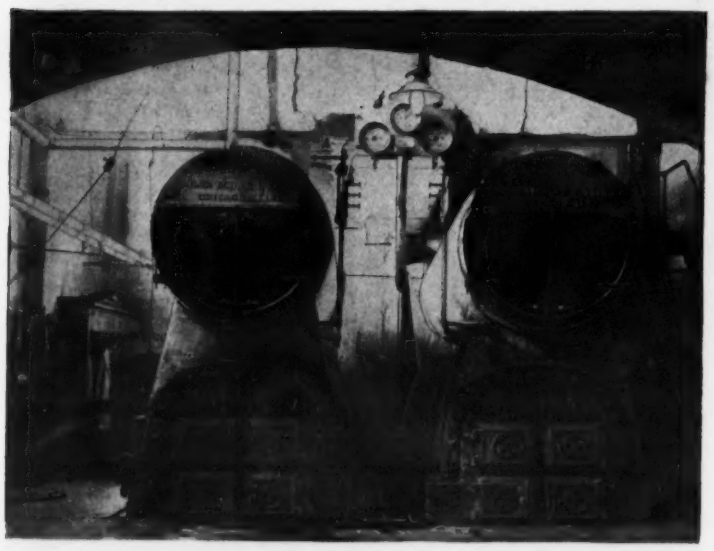


FIG. 3.—BOILER ROOM.

is of white enamel brick, while the floors are of cement. Brass railings surround the generators. The room contains two single-cylinder, four-ported engines, built by A. L. Ide & Co. They are speeded to 270 r.p.m. and are each direct-connected to a General Electric multipolar, 125-volt generator, with a capacity of 652 amp. The generators are compound-wound, the series fields of the two machines being connected by an equalizing bar. The leads from the generators run in pipe conduits under the floor to the switchboard. This consists of three panels. The two similar generator panels are each supplied with a General Electric circuit-breaker, a Thomson astatic ammeter, field rheostat and plug connections to the voltmeter, located on the feeder panel. An 800-amp., single-throw, three-pole switch on each panel controls the generator current. The center poles of the switches are connected to the equalizing bus-bar, between the series fields of the generators.

The feeder panel is equipped with six 300-amp. and two 400-amp. switches. The two larger ones control the supply of current to the pressroom and to the office building. Through one of the remaining switches current is supplied to the large searchlight placed on the dome of the office building. The remainder of the switches govern lighting circuits and the several motors used for ventilation, electroplating, planing electrotypes, operating the ash conveyor and other purposes. A fourth panel corresponding in size and appearance to those of the switchboard and placed on the same framework carries the pressure and vacuum gauges of the heating system.

From the switchboard two 1,200-cm. cables lead to a local switchboard in the pressroom, 175 ft. distant. For the greater distance

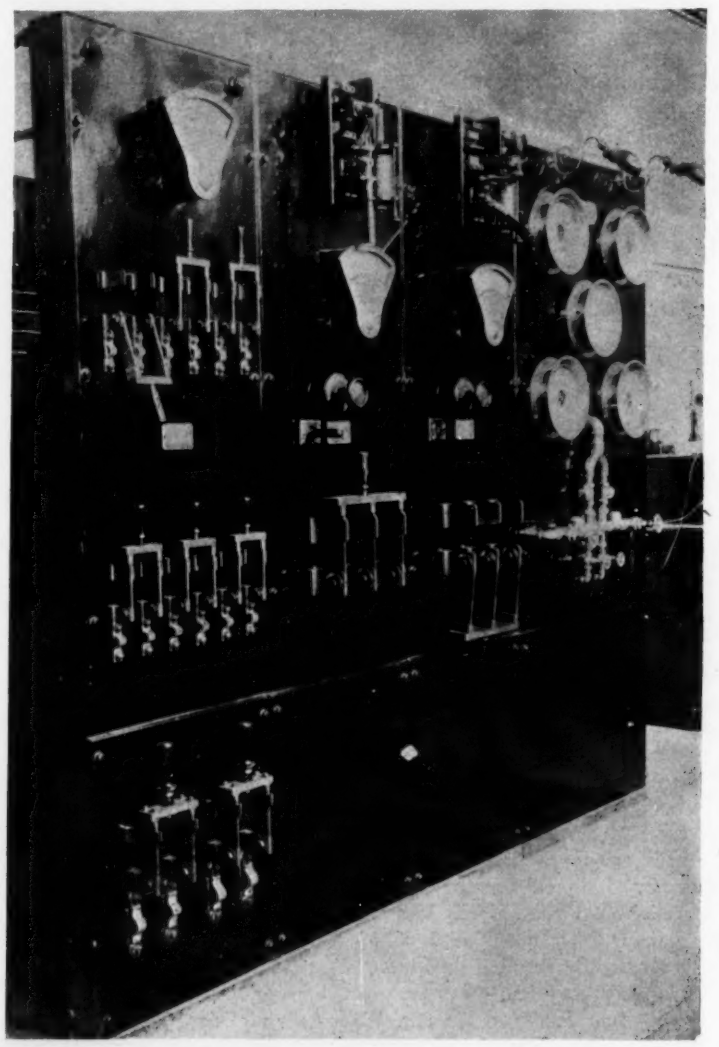


FIG. 4.—SWITCHBOARD.

these run through a tunnel under the center of the pressroom. At the local switchboard current is distributed to the presses, folders and binders. In the accompanying illustrations of the pressroom the absence of belts is very noticeable. In all there are twenty-two motors in the pressroom, which is 275 ft. long by 100 ft. wide. Five of these are of 5 hp each and operate Miehle flat-bed presses, being controlled by controllers which permit running above and below normal speed. The remaining 15 motors of 2-hp each are connected to Dexter folding machines and four Kidder presses. The method of belting the motors to the presses is shown in one of the accompanying engravings. All the distributing system between the sub-switchboard and the machines in the pressroom is encased in unlined iron pipe conduit. The leads are brought up through the concrete floor as near as possible to the base of the motors, thereby adding much to the neatness in appearance of the room. Starting boxes are

placed conveniently on each machine, as may be seen in the reproduction of the folders. The wiring to the boxes is encased in iron pipe conduit. Each machine is also provided with two or more push buttons, by means of which the motor may be shut down from convenient points about the machine without throwing the main switch. In lighting the pressroom more than 200 incandescent lamps are used, in addition to 11 arc lamps.

Several feeders run direct from the switchboard in the engine-room to the office building. The largest set is of 1,000 cm. area. An-

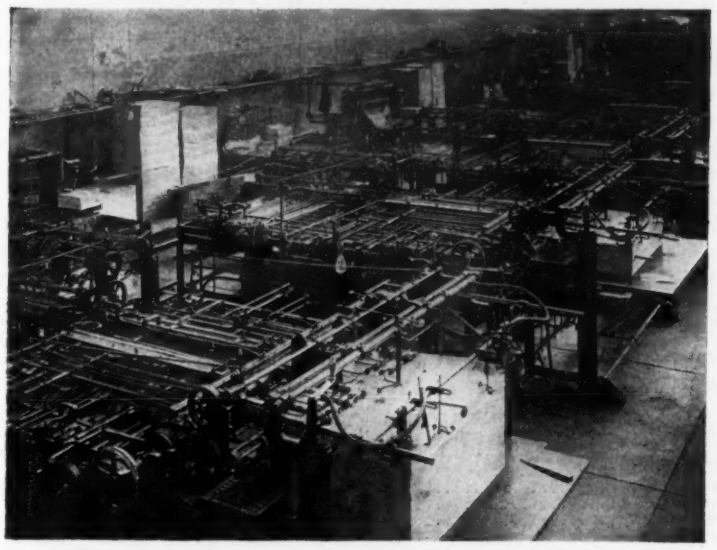


FIG. 5.—MOTOR-DRIVEN FOLDERS.

other set of 750 cm. area feeds the elevator motors. A third pair of the same size runs a distance of 500 ft. to the top of the building, supplying current to the large searchlight. William A. Corrao & Co., of St. Louis, were the contractors for the wiring of the buildings.

The searchlight previously referred to was built by the General Electric Company and is by far the largest and strongest ever constructed. By reason of its excellent location the full effects of its strength are obtained. Situated in the dome of the office building it is 135 ft. above the ground. The building, however, occupies a point considerably higher than the city and the surrounding country,

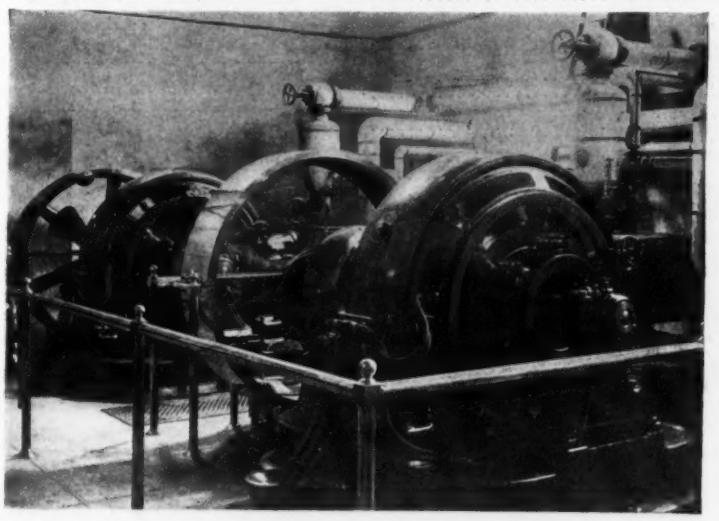


FIG. 6.—GENERATORS AND ENGINES.

so that the light is more than 300 ft. above the city proper. When projected at an angle of about 30°, in which position the beam of light is seen at the greatest distance, the ray is reported to have been discerned at points two and three hundred miles from St. Louis. The strength of the light is such that when thrown on the outlying city of Clayton, three miles distant, no difficulty is experienced in reading a newspaper by its light. The lamp itself is 84 in. in diameter. The parabolic mirror behind the arc measures 80 in. This mirror, which is of foreign make, in itself entailed an expense of about one-third the total cost of the lamp. The carbons are set horizontal or parallel to the ray of light, the negative carbon being placed nearest the reflector. With this position of the carbons the intense light from the crater of the positive carbon is thrown directly into the reflector. The crater at times assumes a depth of 2½ or 3 in. The positive carbon is 2¼ in. in diameter and is cored. The negative is solid, having a diameter of 1¾ in. The current, changing somewhat with the length of the arc, varies from 300 to 350 amp. Because of the purity of the carbons employed very little hissing is present. However, the intensity of the heat is such that there is a constant flaming, the flame rising several inches above the carbons. To avoid rising temperature in the lamp, liberal ventilation is obtained by openings at the top. By this means the temperature is kept down

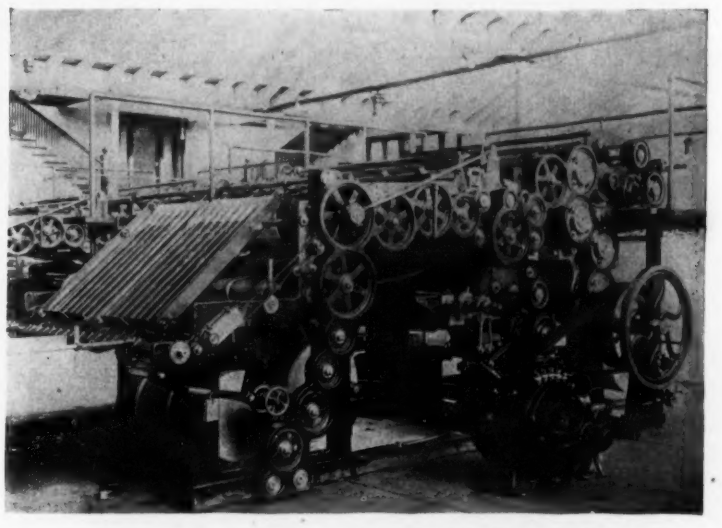


FIG. 7.—ONE OF THE MOTOR-DRIVEN PRESSES.

to such a point that the hand can be placed on any point of the exterior of the lamp. Opposite the arc numerous openings fitted with ruby glass are provided through which the operator may observe the condition of the arc, when making adjustments. By means of several devices the arc may be adjusted to any position. Its position relative to the mirror may be changed by a crank projecting from the front. By so doing the rays may be diverged or concentrated, as may be desired. An attempt to concentrate too intensely results in a crossing of the rays, which is readily distinguishable by a lessened diameter of the beam of light at the point of crossing.

An interesting effect in the appearance of the ray when viewed from a point near the searchlight is the seeming sudden chopping

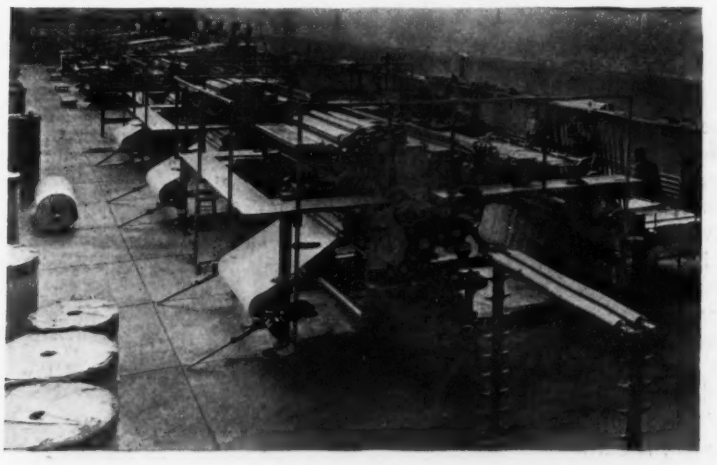


FIG. 8.—PRESSROOM.

off of the beam. The greater the distance of the point of sight from the beam the more distant is the point at which it appears to be destroyed. This effect is due to the power of light to refract and not reflect beyond the critical angle. The mechanism of the lamp is so arranged that the beam may be thrown in any direction. It may be revolved completely on its base or may be swung upon its supporting trunnions for raising or depressing the beam. As the lamp is delicately balanced, these movements may be accomplished by hand, and for operating in this manner convenient handles are provided. Through a series of gears adjustments of direction may be made more delicately by two cranks at the base, one for horizontal and one for vertical motions.

It is, however, customary to provide large searchlights with means for control from a distance. This light has been supplied with such a system of electric control. Two small motors, one for vertical, the other for horizontal movements, are placed in the base, together with resistances, gearing and other mechanism. The motors are operated by means of a controller, which can be placed in any convenient position within the radius of the 200 ft. of connecting cable. A lever projecting from the top of the controller, by the proper movement, gives any direction of motion desired. Connections are so made that the movement of the lamp corresponds to the position of the lever; that is, when the lever is thrown counter clockwise the lamp revolves in a similar direction; if the lever be thrown down

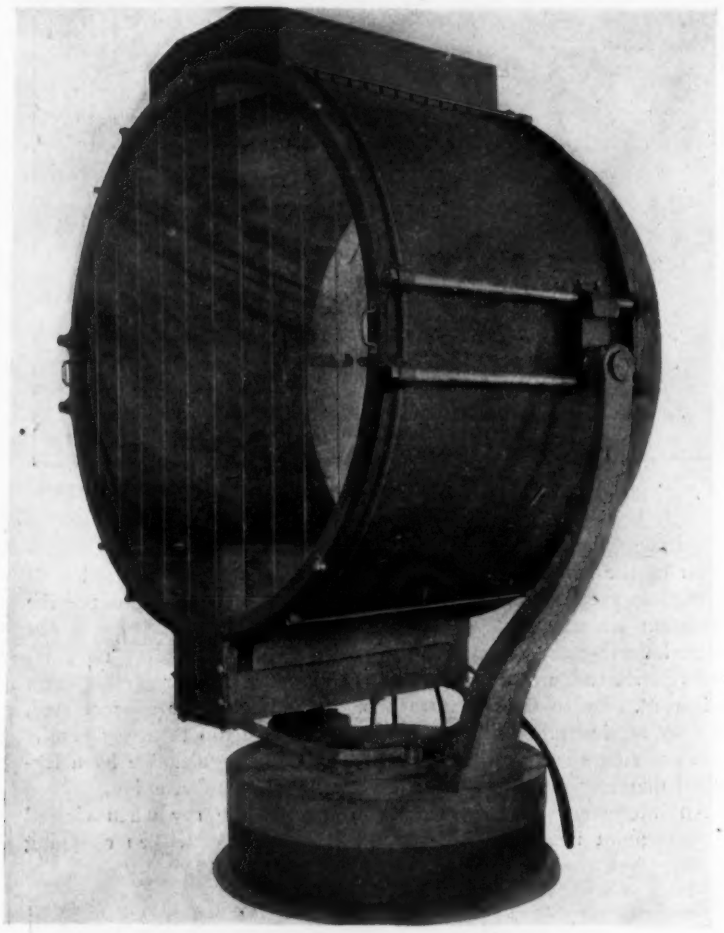


FIG. 9.—80-INCH PROJECTOR.

the light is depressed, etc. By a diagonal movement of the controller handle both motors may be made to operate simultaneously and the lamp be given a diagonal or a combination of vertical and horizontal motions. An increasing pressure on the controller handle gives three speeds, either in a vertical or a horizontal direction.

In the construction of the Woman's Magazine Building special provisions were made for the accommodation of the lamp. It occupies the center of the copper, dome-shaped roof. Beneath it is steel framework, into which it is lowered when not in use. When so lowered, the trap doors above are closed and the exterior of the building presents no evidence of its existence.

This plant, like that of the Government Printing Office at Washington, is but another striking instance of the manner in which electricity dominates in the modern art of printing. It not only lights but it supplies power. It not only drives the presses, but it operates the folders. In fact, it is now difficult to find one branch of the publishing art in which electricity is not already valued as an indispensable agent and auxiliary.

Statistics of American Steam Railways.

Advance sheets of Poor's Manual of Railroads give some very interesting statistics of the great field upon the conquest of which electricity is now entering. According to the statistical exhibits in the introduction the length of steam railroads in the United States on December 31, 1903, was 207,604 miles, a net increase of 4,595 miles in the year. The following statement shows the miles of line constructed in each year since 1880, the total length of railroad in the United States at the end of each year, and the net increase in length from year to year:

	Miles constructed.	Total mileage.	Net increase.
1880	6,709	93,262	6,706
1883	6,819	121,422	6,745
1893	2,857	177,516	2,346
1903	4,715	207,604	4,595

In 1860 the mileage had been increased to 30,626 miles; in 1870 to 59,922, and in 1880 to 93,296. Then began the greatest boom in railroad construction that the world ever witnessed, resulting in the construction in a period of four years—1880 to 1883, inclusive—of 34,871 miles of new railroad. This extraordinary wave was followed by a comparative lull extending over two years, during which about 6,800 miles of line were added to the country's railway ramifications, and thereafter the second great wave of railroad construction swept over the country. In the five years from 1885 to 1890, inclusive, the additions to the railway mileage of the country aggregated 38,341 miles, making a total for eleven years—1880 to 1890—of 79,118 miles, or only 7,468 miles less than had been constructed in the previous fifty years. In 1890 the total mileage of railroads equalled 166,654; in 1903 it reached 203,784, the increase in thirteen years being 37,130 miles, or more than 20 per cent.

The following is a general exhibit of the capital and debt, cost of road and equipment, etc., of all the railroads in the United States in 1903, compared with corresponding returns for 1902:

LIABILITIES AND ASSETS.

Liabilities:	1903.	1902.
Capital stock	$6,355,207,335	$6,078,290,596
Bonded debt	6,722,216,517	6,465,290,839
Unfunded debt	448,199,448	310,345,867
Current accounts	648,434,976	479,957,035
Sinking and other funds	115,201,683	140,679,814
Total liabilities	$14,289,529,959	$13,474,565,051
Excess of assets over liabilities	572,851,585	479,542,767
Total	$14,862,111,544	$13,954,107,818
Assets:		
Cost of railroad and equipment	$11,233,311,285	$10,865,683,376
Real estate, stocks, bonds and other invest.	2,653,851,625	2,345,515,940
Other assets	552,036,399	455,053,773
Current accounts	422,912,235	287,854,729
Total	$14,862,111,544	$13,954,107,818

Comparative statement of income account for 1902 and 1903 follows:

Traffic earnings:	1903.	1902.
Passenger	$429,705,287	$396,513,412
Freight	1,344,150,719	1,197,212,452
Miscellaneous	135,001,820	127,089,036
L.	$1,908,857,826	$1,720,814,900
Operating expenses and taxation	1,316,349,314	1,160,788,623
Net earnings	$592,508,512	$560,026,277
Other receipts	89,485,484	77,663,483
Total available revenue	$681,993,996	$637,689,760
Payments:		
Interest on bonds	$239,426,707	$222,614,909
Other interest	8,680,451	9,733,560
Dividends on stock	164,549,147	151,019,537
Miscellaneous	61,336,614	57,408,351
Rentals:		
Interest	38,675,121	40,622,542
Dividends	26,125,268	27,154,215
Miscellaneous	21,320,600	19,970,212
Total payments	$560,113,908	$528,523,326
Surplus	121,880,088	109,166,434

The result of the operations of the railroads of the country is a matter of first importance with the investors and publicists. Examination of the figures in the preceding statement shows that gross earnings increased $188,042,926 in 1903 over the earnings of 1902 and $296,409,000 over the earnings of 1901, an increase of 10.93 per cent. in 1903 as compared with 1902, and an increase of 18.38 per cent. over 1901.

The greatest increase in earnings was in the freight department, which aggregated $1,344,150,719 in 1903, as against $1,197,212,452 in 1902, the increase of $146,938,267 being equal to 12.29 per cent., with an increase of 2.75 per cent. in the average receipts per ton per mile, which in 1903 were 7.85 mills, as against 7.64 mills in 1902 and 7.56 mills in 1901. The passenger and freight traffic in 1903 and 1902 was as follows:

	Miles, 1903.	Miles, 1902.
Railroad operated	205,237.12	197,887.36
Passenger	429,014,116	403,213,878
Freight	548,680,595	508,210,140
Mixed	22,288,855	22,990,130
Total	999,983,566	934,413,448
Passengers carried	696,949,925	655,130,236
Passenger mileage	20,895,606,421	19,706,908,785
Tons freight moved	1,306,628,858	1,192,136,510
Tons moved one mile	171,292,198,079	156,624,166,024

The Single-Phase Railway Motor.

At the October meeting of the New York Electrical Society, Prof. A. S. McAllister, of Cornell University, delivered a lecture on the single-phase motor which, with the discussion thereon, to appear next week, forms a notable contribution to the subject.

In introducing the subject of the evening, Mr. Frank J. Sprague, president of the society, said there is perhaps no one branch of electric traction which is commanding more energetic study, ingenuity and detailed application than the development of the single-phase, alternating current motor.

Scarcely a quarter of a century has passed since Dr. Siemens, in 1879, at the Paris Exposition, and in 1881 at Lichterfelde; Edison at Menlo Park, and Field at Stockbridge, operated experimental equipments supplied by current from a dynamo, that at Lichterfelde being really the first commercial attempt. Sixteen years only have passed since the modern electric railway development began at Richmond; without this development the New York Subway, about to be opened to the public, would have been impossible. This up to the present has proceeded along one very definite line, using in the motor continuous current, originally generated directly and transmitted through the trolley wire to the car, but more recently, of course, on all large installations, transmitted primarily from a central station as an alternating current to sub-stations, and there stepped down through transformers and through rotaries transformed into continuous current.

The common practice the world over has determined the character of the motor as one centered at one end on the axle to which it is geared and by which it is partly directly supported, while the other end is carried from the truck in the same manner as to permanent parallelism of the driving and driven axles under all conditions, as on the Manhattan Elevated experiments in 1886.

The motor has by evolution now been brought to a very simple, efficient and reliable state. We can hardly imagine a piece of machinery so simple in construction, of more all-round efficiency, or more capable of withstanding continued hard service and abuse. It represents the result of hard study and ingenious work by hundreds of designers, guided by the exacting demands of practice.

The potential at which those motors are operated has been, by common consent, limited on account of motor commutation to about 600-650 volts, an increase of only 150 to 200 volts in the past fifteen years. There now seems to have grown up the conviction that this is the limit to continuous-current potentials for practical railway purposes. To that Mr. Sprague took exception. But, be that as it may, it is perfectly clear that if electric railroads are going to extend beyond the tramway, beyond the underground, the elevated and the single-car suburban service, the question of investment in conductors and in apparatus for transforming energy must be very seriously considered. At present an electric railway may be considered as a combination of a series of railways, each operated from a sub-station, which we may call the central station for that division. The railways being joined together, the loads on any section receive current from two or more sources. These stations have dynamos which, instead of being operated from local boilers and steam engines, are driven by current transmitted through a transformer from a distant point at which all the necessary boilers and engines are concentrated.

It is clear that up to the sub-station, whatever is used for operating the motors, whether continuous or alternating currents, has little bearing upon the question of cost or efficiency of initial transmission, because it is possible to transmit the primary current through to these sub-stations at any required pressure, which will not be affected by any change which may take place in the motor *per se*.

What is desirable, and what is sought in this new development, is to get rid in the first place of one of the elements in the sub-station; that is, the rotary or movable one, leaving the step-down transformers as the permanent equipment. The other is to raise the potential on the trolley line considerably above that which has ordinarily been used on continuous-current operation, and therefore increase the distance between sub-stations. Mr. Sprague considered that possibly the hopes in this respect are somewhat exaggerated, and for the following reasons:

When taking up the heavier problems of railway transportation, it is, of course, with the necessity of a plurality of motor equipments, no matter whether we deal with locomotives or with cars distributed throughout a train, and if a plurality of motors be used then, adhering to our present practice of series-parallel operation, it is possible to raise the working potential to, say, 1,300 volts.

Potentials varying from this to about double have been characteristic of much of the alternating-current work thus far proposed, excepting, of course, such experimental development as has been made at Zossen on a military line under the auspices of the German Government. But there are some things we must bear in mind when we deal with these higher potentials, and what they are going to result in. The laws governing losses in transmission with localized loads are quite plain. They may be briefly stated as follows:

With any given amount of energy transmitted, the e.m.f. and current will vary inversely.

With any given work done, loss on a line, e.m.f. at the terminals of the motor and distribution, the weight of copper will vary as the square of the distance, its cross-section of course varying directly as the distance.

With the same conditions, the weight of copper will vary inversely as the square of the e.m.f. used at the motor.

With the same cross-section of conductor, the distance over which a given amount of power can be transmitted will vary as the square of the e.m.f.

If the weight of copper is fixed, with any given amount of power transmitted and loss in distribution the distance over which the power can be transmitted will vary directly as the e.m.f.

Now, in railway service, the average load will ordinarily increase directly as the unit of distance, which means that with any fixed unit investment in trolley copper the distance between sub-stations should increase directly as the increase of potential.

It may also be remarked that the size of sub-stations will also increase, but not quite in the same ratio, and the aggregate capacity should be somewhat less.

If we compare continuous and alternating-current layouts, then, considering maximum potentials, and bearing in mind that the effective working potential of the alternating current is considerably less than the maximum, and further that the iron rails offer much less facility for conducting alternating currents than continuous ones, we will find that if we have a given distance between sub-stations or a continuous-current layout of, say, 1,300 or 1,400 volts, to go double that distance on an alternating-current layout, the maximum potential would have to be raised to not less than 3,000 or probably 3,500 volts.

But whatever the difficulties, and however these various considerations may be viewed, it is important, if possible and safe, to raise the working potential on a trolley line, and it is likewise important if a motor can be built to operate on a single-phase alternating current which will be as satisfactory as its continuous-current rival. As to the polyphase motor, Mr. Sprague considered that for general railway purposes it is absolutely unfitted, despite the admirable work that has been done by the Ganz and Siemens Companies in Europe. Its characteristics are not satisfactory for the class of service, and it requires either two or three wires overhead. As to the single-phase motor, there is an amount of energetic application directed to this one problem which is deserving of all praise, and Prof. McAllister would give an account of the various solutions of its difficulties which have been attempted, and the results which have been accomplished.

The lecture of Prof. McAllister dealt with the characteristics of the plain series motor and its defects; the improved qualities of the induced and forced compensated series motors; the comparative performance of the induction series motor, and its high power factor; the repulsion motor and inverted repulsion motor, and a discussion of the methods for using resistance as condensance to cause motors possessing series characteristics to draw leading wattless current from the supply system.

In his opening remarks, Prof. McAllister showed that if in an alternating field there be placed an armature connected to a commutator by methods common in direct-current practice, it will be found that with the armature stationary there will be generated in the conductors an e.m.f. on account of the rate of change of flux through the armature coils as in a stationary transformer, and that the maximum measurable value of such e.m.f., as it appears at the commutator, will exist between points placed in mechanical line with the field flux and spaced 180 electrical degrees apart. When the armature is in motion neither the effective value nor the time phase position of this transformer e.m.f. is altered, except in so far as other disturbing influences may be brought into play, but, due to the dynamo speed effect, there is generated in the armature coils an e.m.f. which appears externally as a maximum at points on the commutator 90 mechanical degrees from the field flux, as is true

with direct-current generators. This latter e.m.f. is proportional to the product of the speed and the field flux, and hence is in time phase with the alternating field. Experiment verifies the theoretical determination that at synchronous speed the effective values of the dynamo e.m.f. and of the transformer e.m.f. are equal, and due to the fact that they are in electrical time quadrature and mechanically displaced 90°. An e.m.f. of equal value will be found to exist between any two points on the commutator situated 180 electrical degrees apart. From these facts it follows that when such an armature is revolving at synchronous speed in an alternating field of any strength, the effective value of the e.m.f. at the commutator must be the same in all diametrical positions.

In the case of a plain series motor, having an equal number of effective turns on the armature and on the field coils, and with the magnetic reluctance the same in all directions around the armature core, the field coils, under all conditions of operation, act as an impedance in an alternating-current circuit, while, when the armature is stationary, its coils form a similar and equal impedance. Neglecting hysteretic effects, the armature current and the field magnetism are in time phase and in mechanical position to give to the motor a torque which retains its direction with the reversal of flux and current. When the armature is in motion, there will be generated an e.m.f., which appears at the brushes, and which is in time phase with the field flux, or phase opposition to the armature current. At synchronous speed this in-phase component of e.m.f. is just equal to that reactive e.m.f. of the armature or of the field coil, so that, neglecting losses, the power factor would equal the cosine of that angle whose tangent is 2, or the power factor is .446 and the apparent impedance has increased to $\sqrt{1 + .25} = 1.1$ of its stationary value. Thus at synchronous speed the torque, which varies as the square of the current, would be reduced only to 66.6 per cent. of its stationary value. If the frequency be lowered, the speed corresponding to synchronism will be correspondingly altered, but the above relations will yet hold true at this speed. It is, therefore, apparent that the unity-ratio, single-phase, plain-series motor with uniform reluctance around the air-gap is unsuited for traction.

It may be shown that a change in the ratio of field to armature turns only slightly affects the relations given above, unless such change be accompanied with an increase in reluctance of the magnetic structure in line with the brushes. By using projecting field poles, thus leaving large air-gaps in the axial brush line, the local inductive reactance of the armature may be materially reduced, even when an increased number of armature conductors is employed, so that at synchronism the armature speed e.m.f. may be made large in comparison to the reactive e.m.f. of the armature and field circuits, and the power factor will be thereby correspondingly increased, with a resultant improvement in the torque characteristics of the machine. Even under the most favorable conditions, it is impossible to reduce the reactance of the armature circuit to an inappreciable value, due to the inevitable presence of the magnetic material of the projecting poles.

The most satisfactory method of reducing the inductive effect of the armature current is to surround the revolving armature winding with properly disposed stationary conductors through which flows current equal in m.m.f. and opposite in phase to the current in the armature. This compensating current may be produced inductively by using the stationary winding as the short-circuited secondary of a transformer of which the armature is the primary, or the main line current may be sent directly through the compensating coil. In the former case the transformer action is such that the compensation is practically complete, giving minimum combined reactance of the two circuits, while in the latter case the proportion of compensation can be varied at will. It is found that in any case the best general effects are produced when the compensation is complete, and experiments seem to indicate that under such conditions the induced and the forced methods of compensation differ inappreciably for strictly alternating-current operation, but that for direct-current work, where the forced compensation can be used to prevent field distortion and improve the commutation, the latter method is preferable.

Excellent performance of the compensated alternating-current motor may be obtained by using the field coil as the load circuit from the compensating coil employed as the secondary of a transformer, the armature being used as the primary. Under the conditions here assumed, the current in the primary (armature) is in phase opposition to that in the secondary (compensating and field coils), while the field flux is more or less accurately in phase with the secondary current. Since the field flux and the armature current reverse together, the fluctuating torque remains in one direction.

The speed e.m.f. is in phase with the field flux, or approximately in phase (opposition) to the armature current. At synchronous speed, neglecting losses, the tangent of the angle of lag is equal to the ratio of turns in the field coil to those in the compensating coil, and decreases directly with increase of speed, so that the power factor, the corresponding cosine, can be made quite large for synchronous speed, while it continually approaches unity as the speed increases. These statements, which easily admit of theoretical demonstration, are substantially corroborated by experimental observation.

Tests show that the effect of the short-circuit by the brush of a coil in which is generated an active e.m.f. which would tend to decrease the power factor, is counterbalanced by the fact that the field flux lags somewhat behind the secondary current, and the real speed e.m.f., therefore, lags behind the primary current, tending to cause the current to become leading and to increase the power factor. The field flux continually decreases with increase of speed, so that in any case the short-circuiting effect is relatively small.

A slight modification of circuits of the above described induction series motor, such that the primary and secondary circuits are interchanged, leads to the American Atkinson type of repulsion motor. Under starting conditions and up to a speed slightly above synchronism the performance of each machine is quite similar to that of the other. Beyond synchronism, however, the repulsion motor is in all respects inferior to the induction series machine, due to the fact that with the former motor the short-circuiting effect increases with an augmented rate as the speed increases, though of zero value at synchronism, and becomes prohibitive when speed is much in excess of this value. It may be shown that the facts do not justify the claims for high power factor of the primary current due to condenser effects in the secondary low iron loss in any magnetic circuit, except the armature at synchronism, and superior commutation of this machine, except near synchronism, and that the operation of the repulsion motor is limited to the range between zero speed and synchronism.

A type of alternating-current commutator motor suitable for railway service, which, as a subject for theoretical investigation, is of all machines the most interesting, is found in the repulsion series motor. The circuits of this machine are similar in most respects to those of the plain series motor with uniform reluctance around the magnetic circuit, but it possesses an additional set of brushes shunted upon themselves in mechanical line with the windings on the stator. In distinction to the performance of the compensated series motor, in which the effect of speed is to increase the apparent resistance of the armature which possesses negligible reactance, the armature of the repulsion series motor possesses at starting the major portion of the apparent reactance of the motor circuits and the effect of speed is to decrease such apparent reactance continually with increase of speed according to a parabolic law, the reactance becoming zero at either positive or negative synchronism, and negative at higher speeds in either direction. While with the series motor the field circuit constitutes at all times the major portion of the reactance of the machine, with the repulsion series motor the field circuit is practically non-inductive at starting and the effect of speed is to introduce in the coil an apparent resistance which increases directly with the speed, and becomes negative when the speed is reversed.

This behavior on the part of the circuits of the machine is due to the fact that under speed conditions the armature conductors cut the flux produced by the current which flows through the armature coils, the e.m.f. thus generated in the armature at the short-circuited brushes being counterbalanced by an e.m.f. due to the rate of change of flux introduced into the armature core by current in this local circuit, such flux generating in the field coils an e.m.f. in time quadrature with itself and hence in phase (opposition) with the circuit current, giving the effect of resistance and causing the generation at the main brushes of an e.m.f. in time phase with itself, and hence in quadrature with the circuit current, giving the effect of negative reactance. Experiments fully confirm these theoretical deductions. A disturbing influence is found in the fact that the armature is never strictly without apparent resistance, nor the field coils entirely free from reactance, due primarily to the short-circuiting at the brushes, which becomes quite prominent and predominating above either positive or negative synchronism.

If a resistance be placed in shunt circuit to the field coils of a

direct-current, series motor, the armature is in general subjected to an increased torque and the result is an increase in speed. If a similar resistance be placed across the field coils of an alternating-current, series motor, the result is entirely different, since the current, which flows through the resistance, is out of phase and leading with respect to the field flux. Under speed conditions, the current taken by the resistance traverses the armature circuit quite indepently of the current which reaches the field coil, the effect being that the resultant line current leads the impressed e.m.f., so that the resistance acts quite similarly to condensance to cause the power factor to become unity, and then to decrease with leading wattless current. It can be shown that the energy thus absorbed is that incidental to the use of the resistance and that for a given current it is unaffected by the speed e.m.f. Thus the current taken by the resistance multiplies into the stationary transformer e.m.f. to give the actual watts absorbed, while the same current multiplies into the speed e.m.f. to give apparent leading wattless power. Experiment verifies this feature and shows that even a plain series motor with uniform reluctance around the field core may thus be caused to operate at unity power factor at any speed greater than about one-half of synchronism.

The American Production of Aluminum.

In a report on "The Production of Aluminum and Bauxite in 1903," Mr. Joseph Struthers of the United States Geological Survey expresses regret that it has not been possible to obtain exact statistics of the production of aluminum for the reason that the sole producer in the United States, the Pittsburg Reduction Company, declines to state, even approximately, its output. The phenomenally rapid progress in the iron and steel industry in the United States is largely attributable to the willingness of each individual manufacturer to describe and discuss his own practice, and thus, by co-operation, to help the others, and in turn to be helped by them. In spite of the policy of the Pittsburg Reduction Company, it is safe, however, to estimate the production of aluminum in the United States during 1903 at 7,500,000 pounds, as compared with 7,300,000 pounds in 1902, and 7,150,000 pounds in 1901. Mr. Struthers bases this assumption on the fact that the uses of the metal and its alloys have been recently greatly extended. Bauxite, the crude mineral from which aluminum is extracted, has been consumed during the last few years in successively larger and larger quantities, and this also would seem to indicate that the production of aluminum is steadily increasing.

The chief point of interest affecting the aluminum industry in the United States during the year 1903 was the final adjudication of the many lawsuits and counter lawsuits which had been instituted from time to time in behalf of the Electric Smelting & Aluminum Company, operating the Bradley patents. The sum involved was approximately $3,000,000. On October 13, 1903, a friendly agreement was made by the two companies to the effect that the Pittsburg Reduction Company should pay a given sum for the quantity of aluminum produced by it up to the date of the agreement, and should continue the manufacture of aluminum under license of the Bradley patents until the time of their expiration, in February, 1909, paying a royalty for all metal produced in the future. The operation of the Electric Smelting & Aluminum Company is to be restricted to the manufacture of aluminum alloys, although it may handle and sell aluminum in all forms at the works of the company at Lockport, N. Y. By the terms of this agreement there will be no future litigation between the two companies.

The Electric Smelting & Aluminum Company apparently now controls the present electric smelting industry in the United States, as the following companies are more or less subsidiary to it: The Cowles Smelting Company, the Union Carbide Company, the British Aluminum Company, the Electric Gas Company, the Acetylene Illuminating Company, the Willson Aluminum Company and the Acetylene Company.

The progress of the aluminum industry in the United States and in Europe in 1903 is described in detail by Mr. Struthers. There are only three aluminum works in the United States (two at Niagara Falls and one at Massena Springs, N. Y.), one in Quebec, Canada; one in Scotland, two in France, one in Switzerland, one in Germany, and one in Austria. A considerable portion of the report is devoted to a discussion of the technology of aluminum and forms an interesting contribution on the subject.

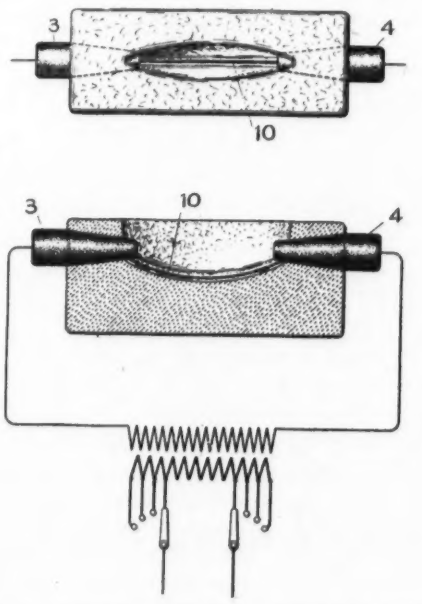
Recent Electrochemical Developments.

ELECTRIC FURNACE.

While the first electric furnaces employed in practice were of the arc type, the resistance type has attracted a great deal of attention in recent years and its design has undergone a very extensive development, notably through the work of Mr. E. G. Acheson and his associates. Mr. F. A. J. Fitzgerald divides the different resistance furnaces into two classes: First, those in which the electric current passes through the whole charge (like the Acheson furnace for making graphite electrodes); and second, those in which the current passes along a definite path, thus localizing the heat (like the Acheson carborundum and "white stuff" furnaces).

In the carborundum furnace there is a single conducting core of granular carbon or a carbon rod in the center of the furace, surrounded by the charge of sand and coke. In the "white stuff" furnace in which great uniformity of temperature is required, several conducting cores are used, definitely spaced with relation to each other. In practically all resistance furnaces of this type in commercial use, the charge surrounds the conducting core. This would appear to be the logical design in view of the necessity to confine the electrically generated heat to the charge where it is needed, and to avoid losses by radiation. The only exception to this general method of construction has been, up to the present, the ferro-alloys furnace of M. P. Girod, consisting of a crucible of refractory material, surrounded by a resistance of graphite in granular form. The carbon electrodes are placed equidistant around the resistance material surrounding the crucible. Between the carbon electrodes and below and above the crucible, fire bricks are fitted. (For further details see *Electrochemical Industry*, August, 1904, p. 309.)

Similar to this, in its general arrangement, is a furnace for which a patent was granted on November 1 to Mr. Charles Proteus Steinmetz. The walls of the furnace are made of the material which has to conduct the current for generation of Joulean heat, and the charge to be treated is contained either directly within the walls or enclosed in a vessel of very refractory material. The chief feature is, however, the use of "pyro-electrolytes" for the current-conducting material. With this name Mr. Steinmetz designates those refractory materials—such as refractory oxides, silicates, wolframates, chromates, etc.—which have a comparatively high resistance at ordinary temperatures, but become good conductors when heated. Thus we have here the principle of the Nernst lamp applied to electric furnace work.



FIGS. 1 AND 2.—DIAGRAMS OF ELECTRIC FURNACE.

The furnace is shown in Figs. 1 and 2, which represent a plan view and a sectional view, respectively. The illustrations are practically self-explanatory; 3 and 4 are carbon rods embedded at the two terminals within the block of pyro-electric material. As in the Nernst lamp, preheating of this material is, of course, necessary. This may be done either from the outside, for example by means of a blowpipe, or from the inside by means of a carbon filament, 10, within the furnace. This carbon filament is thus analogous to the

auxiliary wire which preheats the oxide filament of the Nernst lamp.

The voltage drop within the pyro-electric material is stated to be of the order of 1,000 volts per inch. The possibility of producing and maintaining easily a certain temperature within a rather wide range is the main claim made for this furnace.

USE OF ELECTROLYTIC CHLORINE.

While in some processes of electrolysis of chlorides (like the Browne process of separating nickel from copper and the Swinburne-Ashcroft process for treating complex sulphides) chlorine is made to go through a complete cycle and is used over and over again, the well-known commercial processes of electrolyzing common salt give caustic alkali and chlorine as final products of electrolysis. The chlorine is mostly used for making bleaching powder, but the low market price of the latter has induced the manufacturers to cast about for other uses of their electrolytic chlorine. In this connection a patent, granted on November 1 to Mr. C. Kellner (one of the inventors of the Castner-Kellner process), for the manufacture of cellulose, is of interest.

The portions of plants from which cellulose is to be produced are treated with water, or preferably with milk of lime or a very weak solution of an alkaline carbonate or hydroxide, and after the excess of liquid has been removed, the plants are subjected to the action of electrolytically produced chlorine gas. This causes the incrusting substances (lignines) to be oxydized so extensively as to convert them into substances which, while in many cases completely soluble in hot water, are in all cases completely soluble in very weak alkaline liquids.

ELECTRICAL TREATMENT OF AIR.

In processes in which chemical effects are produced in gases by means of electric discharges—for instance, for the purpose of the fixation of atmospheric nitrogen—the frequency of the discharges and the rate of the supply and removal of the gas under treatment must bear a certain relation to each other. A patent granted on October 25 to Messrs. J. E. Mitchell and D. Parks, refers to an apparatus in which the pump for the air supply operates in combination with a device which removes the points of discharge from each other, means being provided for synchronously operating the electrodes and pump.

BATTERY INVENTION.

In a patent granted on November 1 to Mr. E. A. Sperry, a method of storage battery electrode manufacture is described, in which a carbonate of lead is precipitated from a solution of a lead salt and is then roasted to expel the carbon dioxide and to produce a highly porous oxide of lead which is applied to a grid as support. Another patent of the same inventor refers to details of construction of terminal connections for storage battery plates.

Mr. J. Diamant, in a patent dated November 1, proposes to add to the electrolyte a "sulphonic acid," derivative of methane in the electrolytic production of lead peroxide layers. For the sake of lightness, Mr. C. B. Morgan (November 1) proposes aluminum plates provided with pockets as support for the active material. Mr. C. F. Mackey patents (October 25) details of construction of dry cells, Mr. E. G. Dodge (October 25) details of construction of clamps for battery electrodes, and Mr. L. W. Pullen (October 25) details of construction of a medical battery.

CURRENT NEWS AND NOTES.

PRIZE AND PENALTY BY TELEPHONE.—About two years ago a student graduating from Purdue University received his degree over long-distance telephone. Another novel but not original use was made of the telephone a few days ago at Salem, N. J., when a hunter who had violated the game law entered his plea over the telephone and was fined $26 by the justice, who was at the other end of the line.

STEAM ROAD OPERATED BY TELEPHONE.—The Duluth, Virginia & Rainy River Railroad Company is, according to the reports filed with the Minnesota State Railroad and Warehouse Commission, the only steam road in Minnesota using telephones to the exclusion of telegraphs. The report shows that 36.44 miles of telephone lines are operated by the road and no telegraphs. The road runs between Rainy Junction and Ashawa, a distance of 27.7 miles.

TELEPHONY IN CHICAGO.—In an opinion on the telephone ordinance of 1899, Corporation Counsel Tolman has ruled that the Chicago Telephone Company shall pay the city 3 per cent. of its receipts from its telephones in the territory annexed after the passage of the ordinance. Between $300,000 and $500,000 is involved. He also held that the company has no right to charge tolls within the city limits, and that the city can compel the company to enclose public telephones in boxes or booths.

ELECTRICITY ON THE ERIE RAILROAD.—It is reported that the Erie Railroad management has under contemplation plans for the introduction of electric power for suburban service throughout New Jersey. The plans call for a central power station at Paterson, power to be distributed therefrom within a radius of 18 miles. Some 51 miles of road in all will be affected by the change. Other large improvements to the company's property are said to be under contemplation, involving a total outlay of $30,000,000.

NO LOCOMOTIVES IN BROOKLYN.—The Long Island Railroad has just contracted for its first electrical equipments. Last week for the first time in the history of Brooklyn every train of its big elevated system was operated by electricity. The entire locomotive force of the Brooklyn Rapid Transit was housed in the different elevated yards and motor cars and third rails did the rest. After many discouragements and delays the last of the antiquated locomotives went into the yard and dumped their fires. The road is now trying to sell them.

BURGLAR KILLED BY CURRENT.—A special dispatch of November 1 from Montgomery, Ala., says: "James Hendrix, 22 years old, one of the most prominent young men of this city, was found dead early this morning on the roof of the American National Bank Building with a set of burglar's tools lying near him. Apparently he had been killed by electricity while trying to cut a wire. In his pockets were dynamite, nitroglycerine, fuses and a pistol. Hendrix was dressed in his militia uniform and his plain clothes were found at the armory of the Montgomery Grays."

ORIGIN OF RADIUM.—Sir William Ramsay in a recent lecture on radium referred to the fact that not only is the proportion of radium to uranium in rocks wherever found apparently the same, thus pointing to the uranium origin of radium, but also that the amount of helium in the composition of rocks possibly affords an internal record of the rock. It is too early to offer a reliable assertion as to the origin of radium, yet there is reason for believing that uranium is its parent and predecessor. Possibly, therefore, uranium is an unstable element and slowly degenerates atom by atom into radium, the time of half loss being, say, a billion years. Radium again degenerates into helium and other products, which in turn go through relatively shorter periods of degeneration into more stable but relatively de-energized forms of matter. It was pointed out that the evidence was strong in favor of the belief that the energy liberated by radium and its emanations was internal energy of degradation and not energy reflected from without.

A PECULIAR TELEPHONE ACCIDENT.—An Indianapolis correspondent refers to a curious accident which caused the partial paralysis of James Adams, of that city. Mr. Adams is a subscriber to the services of the Central Union and the New Telephone Companies, the instruments of both standing close together on his desk. He called for a subscriber on the New instrument and while waiting for the answer, with the receiver at his ear, rested his chin on the top of the Central Union instrument. He received a shock which rendered him unconscious and he fell to the floor paralyzed from his waist down. He is expected to recover, although life was despaired of for a time. Telephone men state that they never heard of an accident like it, and give as a possible reason for such a result that Mr. Adams' nervous system must have been in a peculiarly sensitive condition to be so affected. The ordinary telephone current is not sufficient to harm any one. Opponents of dual telephone service may find in this accident an argument in support of their contention rather out of the common.

LETTER TO THE EDITORS.

Copper vs. Iron Lightning Rods.

To the Editors of Electrical World and Engineer:

SIRS:—In looking over my scrapbook I find a report of a lecture by Prof. Lodge in which he states that in the case of a charged surface discharging to points "when copper was used, the discharge took place with a sharp crack. With iron the discharge produced less noise, and with a wet string hardly any; yet the latter was efficient in protecting the other two conductors." He then maintained that "iron was quite as efficient a conductor as copper for ths purpose, and further that, due to the intensity of action, copper was more likely to set up a side flash than iron." But farther along he says, "although the latter (iron) in protected buildings had been the cause of most lightning accidents." It will thus be seen that, by his own admission, practice does not agree with the theory first quoted. It is plain to my mind why the copper should cause the intensity of action described, and consequently the superiority of copper over iron for the purpose of lightning protection. The copper being a better conductor than iron or a wet string, the discharges went with greater violence to the copper conductor, and as a consequence it should be a better protection from lightning to the surroundings than iron, and besides would carry the discharge to earth better than iron.

BALTIMORE, MD. ALFRED G. DELL.

DIGEST OF CURRENT ELECTRICAL LITERATURE.

DYNAMOS, MOTORS AND TRANSFORMERS.

Unipolar Dynamo.—SEIDENER.—An illustrated article on the design of unipolar dynamos for which the author believes the prospects to be now good in connection with steam turbines. The main difficulties with unipolar dynamos have so far been found in the high speed required for producing commercial voltages, and in the method of collecting the current at high speeds. The author first makes some remarks on Faraday's disc machine and on Forbes' cylinder machine; the latter offers a great mechanical difficulty in the necessity of balancing a solid cylinder; on the other hand, its e.m.f. is twice that of the disc machine for the same speed. The author proposes a double-disc machine, as shown in Fig. 1. If the

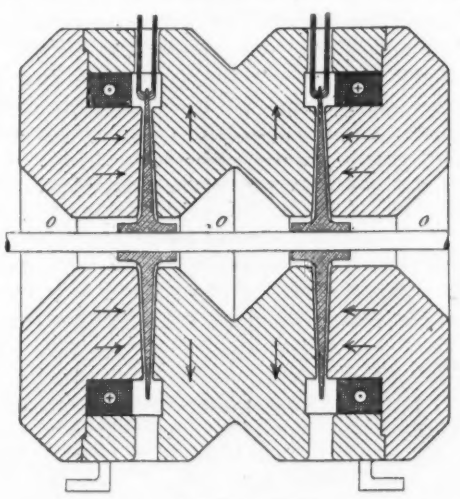


FIG. 1.—UNIPOLAR DYNAMO.

two discs are connected together by common conduction axle, the current is taken off at two points only, i. e., at the rims of the two discs, therefore at the points of maximum speed. Such a machine may, of course, be used for a three-wire system, if the neutral wire is connected by means of a brush to the common axle. The author recommends collecting the current laterally, since a disc revolving at a very high speed represents nearly a plane surface. He believes that a brush sliding on the side of the disc will make a very good and uniform contact at high speeds. He gives a diagram for the weights and sizes of machines generating 5 to 550 volts and running at a speed of 1,500 to 12,000 revolutions. He recommends making the discs of steel. When driven by steam turbines, running at a very high speed, he believes unipolar dynamos to have good prospects.—*Zeit. f. Elek.* (Vienna), October 23.

REFERENCES.

Alternating-Current, Series Motor.—WEICHSEL.—An article on the theory of the circular diagram of the alternating-current, series motor. He shows that this diagram is identical in every respect with that of an ordinary choking coil. The complete analogy between the two cases is pointed out.—*Elek. Zeit.*, October 20.

Direct-Current Dynamos.—MARQUEYROI.—The first parts of what appear to become an extended serial on the armature windings of direct-current dynamos. The article is illustrated by diagrams and is chiefly mathematical.—*L'Eclairage Elec.*, October 15, 22.

Multiple-Voltage Control of Motors.—MEADE.—An article illustrated by diagrams showing the principles of and connections used in multiple-voltage control of motors.—*Power*, November.

LIGHTS AND LIGHTING.

Temperature of the Arc.—WAIDNER AND BURGESS.—An account of an experimental research, the results of which, taken together with those of former investigators, show that the photometric methods based on the extrapolation of Wien's equation give the "black body temperature of the arc" (pure graphite) as at least 3,750° absolute temperature, so that its true temperature must be higher than this. It is not possible to state how much, in the absence of more definite knowledge concerning the departure of carbon from black body radiation. In the light of the best evidence that is at present available it would seem that the true temperature of the hottest part of the positive carbon is between 3,000 and 4,000° absolute temperature (2,727 and 3,727° C.).—*Phys. Rev.*, October.

REFERENCE.

Renewal and Tests of Lamps.—Wilmshurst has recently made the following proposals: First, to renew periodically consumers' lamps, free or on easy terms; secondly, to inspect periodically consumers' lamps *in situ;* thirdly, to test, free of charge, and report on, consumers' lamps. With respect to these proposals an extended discussion has been going on for considerable time and is still being continued, each issue containing the opinion of four or more station engineers or consulting engineers. At the conclusion of the discussion a summary will be given.—Lond. *Elec. Times*, every issue, beginning with July 28, up to October 20.

POWER.

Boiler House Economies.—SHAWFIELD.—A communication referring to the paper of Downe, recently noticed in the Digest. The writer contradicts the too-easily accepted theory that mechanical stokers are "an infallible cure for heavy fuel bills." He has had considerable experience with both methods of firing, and has carried out experiments lasting several months with different classes of mechanical stokers, and in every case the result has shown that the machine stoker is inferior to the human variety in respect both of steam-raising capacity and economy. "It is true that in large stations the adoption of mechanical stokers will somewhat reduce the wages bill; but if, in a station like Edinburgh, the maintenance of the stokers worked out 13.36 cents per ton of coal consumed, the net saving must be very small indeed." The bonus system for firemen, advocated by Downe, would appear likely to be productive of excellent results, but in fairness to the men, it would be better that the basis upon which the bonus is calculated should be the pounds of water evaporated per pound of coal burned, rather than the pounds of coal burned per unit generated. He emphasizes the necessity of testing the calorific value and ash percentage of every load of coal which is delivered. By constant testing he has obtained a remarkable improvement in the quality of the coal supplied, the

calorific value having increased nearly 20 per cent. during the last three years, although the coal was supplied from the same seam at the same colliery during the whole of that period.—Lond. *Elec.*, October 7.

REFERENCES.

Hydro-Electric Plant.—BIGNAMI.—An illustrated description on the hydro-electric station in the Valais County in Switzerland. This plant is stated to utilize the highest head of water in the world. The height of the waterfall is 3,116 ft. and the fall utilized is 3,018 ft. Under this condition and with an efficiency of 75 per cent. at the turbines each liter of water per second gives 9.2 hp. There are four 500-hp alternators generating single-phase alternating current at 6,000 volts. The dynamos run at a rate of 1,000 revolutions.—*Elec. Rev.*, October 29.

Heat Radiation from Steam Pipes.—A communication with reference to a recent article of Davies. The writer points out that the better classes of asbestos used for non-conductive purposes are far superior to the so-called asbestos compositions and millboard.—Lond. *Elec.*, September 30.

TRACTION.

Worm Reduction in Tramway Equipment.—DOMON.—An article stating that the Oerlikon Company is making a new attempt to apply an improved worm gear and other contrivances to trolley car equipments. A car with the new equipments has been installed on the Oerlikon-Zurich trolley line. Besides the wear-and-tear question, which is sure to turn out to the advantage of the worm reduction gear, it has already been possible to ascertain that the worm reduction car runs more smoothly than the car with spur gear, and, besides this, without noise from gears, and without the hammer blows caused by the heavy motors being rigidly journaled on the car axles. Moreover, with exactly the same controllers, the transition from one speed to another is smoother, which is accounted for by the higher speed and lighter mass of the motor. The energy consumption tests have shown that there is practically no difference between the two systems in this respect, which means that the over-all efficiency is the same. When the car is running down grade by its own weight, the efficiency (backward) of the worm is less than that of the spur gear. The difference is illustrated by the fact that the worm gear car will start on only ¾ in 100, track conditions and car weights being equal. This backward efficiency is, however, of quite secondary importance and would only have to be taken into consideration if the use of regenerative principles were contemplated. The main features of the new equipment with worm reduction gear are, besides the improved worm gear with its ball thrust bearings, the flexible and insulated connection between the worm and the motor shaft, the insulation of the motor itself, and the position of the motor at the side of the track, which makes it accessible from the side without the use of pits. In the car equipment referred to the two motors are fixed insulated on the suspended frame of the track, and transmit each 20 hp measured on the tire, the motor running at 1,200 r.p.m. for the standard speed of 9½ miles an hour. The worm reduction gear fixed on the extended axle outside the car wheel secures quite smooth running and especially starting. The gear has been designed so as to be extra strong.—Lond. *Elec. Rev.*, October 21.

Trolley Cars.—ALDWORTH.—A British Municipal Tramway Association paper on the equipment and maintenance of cars. He first makes some general remarks on the design of cars and the construction of the motors. He has tried several kinds of white metal for lining motor and armature bearings, also solid gunmetal armature bushes of different mixtures; the latter, however, are not being renewed, but when worn down are bored out and run up with white metal, instead of being scrapped. This has been found to answer well, besides effecting some saving. A metal is now being tried for lining, composed of three parts virgin spelter and one part block tin, which is considerably harder than any other white metal tried. This has not been in use sufficiently long to enable particulars to be given on mileage to be obtained from bearings so lined, but so far they have given good results, the journals being in excellent condition, and the author believes they will give a considerably increased mileage. He also thinks that considerable advantage would result from having commutators ground true, instead of being turned up in the lathe. He also makes some remarks on trolleys, brakes, wheels and axles and gives rules as to inspections and reports and on the equipment of repair shops.—Lond. *Elec.*, September 30.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Canada.—JOHNSON.—Some statistical notes on electrical progress in Canada. The writer first gives rather full statistical data on telegraphic traffic in the various countries of the world. Canada in 1903 had 36,780 miles of line, and 96,728 miles of wire, and her record is 5,313,800 messages, or about one message for every inhabitant. Electric railway construction of Canada comprised in 1903 single track, 454.75 miles, and double track, 192.54 miles, while the number of passengers carried in 1903 was 167,704,000, or about 31 times the population. The writer then gives some data on telephony and on electric light, heat and power companies. The number of the latter was 80 in 1891 and 316 in 1903. Ontario has 63 per cent. of all stations.—*Cassier's Mag.*, November.

REFERENCES.

Fittings.—Full illustrated descriptions of various fittings and appliances for electric lighting, heating and cooking made by English companies. The description covers 28 pages.—Lond. *Elec. Rev.*, October 21.

Switchboard.—ROWE.—The first article of an illustrated serial on modern high-potential switchboard practice.—*Elec. Rev.*, October 29.

ELECTRO-PHYSICS AND MAGNETISM.

Properties of Current-Bearing Matter.—HEYL.—An account of further investigations of the question whether the physical properties of matter are changed by an electric current passing through it. His present researches related to tensile strength and melting point and the results were negative. The author found that any change in the tensile strength of iron for a current density of 2,000 amp. per square centimeter cannot exceed one-half of one per cent., and for copper, with a current density of 1,000 amp. per square centimeter, the alteration cannot exceed one-fifth of one per cent. Any change in the melting point of tin for a current density of about 2,500 amp. per square centimeter can hardly exceed 2°. There is, however, some reason to believe that a more powerful method would definitely show a small rise in the melting point.—*Phys. Rev.*, October.

Radioactivity from Crude Petroleum.—BURTON.—An account of an investigation in which he found that fresh, crude petroleum contains a strongly radioactive gas which is similar in its rate of decay—and also in the rate of decay of the induced radioactivity which it produces—to the emanation from radium and to the emanations obtained by a number of experimenters from mercury and from certain waters fresh from the earth. There are indications of the existence in crude petroleum of slight traces of a radioactive substance more persistent than the radium emanation.—*Phil. Mag.*, October.

Conductivity of Spark-Gaps.—BOYNTON.—In a study of the high-frequency (Tesla) induction coil it has been found that the resistance of the spark-gap in the primary circuit might be of the order from 100 ohms down to 10, or possibly even 5 ohms. In a recent investigation by the writer, who used as spark-gap zinc knobs of about 2 cm. diameter mounted on glass standards, it was found that for a part of the time at least the spark-gap offers a resistance of much less than 1 ohm to the passage of a large oscillatory discharge.—*Phys. Rev.*, September.

ELECTRO-CHEMISTRY AND BATTERIES.

Refractory Materials.—FITZ GERALD.—An article on the various refractory materials which may be used as a furnace lining in electric and resistance furnace. While for many purposes the ordinary refractory materials, such as silica, magnesite, dolomite, etc., may be used, yet when the temperature is much above that used in ordinary furnaces, it becomes necessary to look for some other substances. The most promising ones for this purpose are certain products of the electric furnace and especially certain compounds of carbon and silicon, which the author calls silico-carbides. He gives a review of the literature of the subject and then describes some experiments made by himself. The use of silico-carbides is limited by their conversion into carborundum at high temperature. They are, therefore, useful within the considerable range of temperature between that at which ordinary refractory materials break down and the temperature of formation of crystalline carborundum. In many cases a comparatively thin layer of silico-carbides is sufficient to effectively protect fire bricks from fusion; but to substitute bricks

made by silico-carbide for fire bricks, dispensing with the latter altogether, is not advisable, since the silico-carbides are much better heat conductors than ordinary fire bricks. Hence, if they are used alone they cause a serious loss of heat and should not be used in general. Silico-carbides are fairly good electric insulators, although probably better conductors than ordinary fire brick heated to the same temperature. The author then describes methods of moulding silico-carbides into bricks or tiles; a very satisfactory bond is gas tar. When an article of great mechanical strength is required and the use of tar is objectionable, the method of making the article is by causing the particles of the silico-carbides to frit together by oxidation. When the temperature in the furnace is above that of the formation of carborundum, it may be advisable to use carborundum in the first place, although it is possible to use the silico-carbide at first, allowing it to be converted into carborundum *in situ*. The same binding agents may be used for carborundum as for silico-carbides. The oxidation method mentioned above is also applicable. Another method of making articles of carborundum is by re-crystallization. The temperature limit to the use of carborundum is reached when it decomposes, silicon escaping as vapor and the carbon remaining as graphite. At temperatures above this decomposition there appears to be no refractory material that can be used except carbon. The best form of carbon for this purpose is charcoal, since its electrical resistivity is high. The article is concluded by a description of methods for the analysis of silico-carbides and carborundum.—*Electrochem. Industry*, November.

Refractory Materials.—E. K. SCOTT AND FITZ GERALD.—A communication by Scott describing some experiments in which chunks of magnesite were shrunk in the electric furnace, to drive off all carbon dioxide. The material thus obtained is very hard and has a fine crystalline structure. He proposes to use it for refractory linings. In a communication on the same subject, Fitz Gerald remarks that while this electrically-shrunk magnesite may be quite useful for the highest temperatures attainable in gas furnaces, it is not refractory enough for the electric furnace. It is not as refractory as silico-carbides or carborundum.—*Electrochem. Ind.*, November.

The Film on the Aluminum Anode.—MOTT.—An article in which the author discusses the method of formation of the insulating films upon the aluminum anode, its composition and chemical nature in the light of the general phenomena of colloidal precipitation. Solutions of chromates, phosphates, tartrates, citrates, etc., strongly precipitate colloidal aluminum hydroxide. The same electrolytes produce an insulating film and aluminum anodes. These films also show absorptive phenomena similar to those observed in colloidal precipitation. It is found that film formation on an aluminum anode and colloidal precipitation are closely allied phenomena. The writer first considers the composition of the film and reaches the conclusion that it consists of aluminum hydrate combined with basic salts of aluminum, or, stating it in another way, the film consists of aluminum oxide, water and an acid radical. The aluminum hydroxide is first produced on the aluminum anode, and this reacts with the electrolyte. The phenomena of taking up the acid radical from the electrolyte is called absorption, and here the valence of the acid radical is of decisive importance. The loose and incoherent aluminum hydroxide absorbs the acid radical by its great chemical affinity, to form a very hard, dense, insoluble solid, which produces great insulating power. The necessary thickness of the insulating film varies with different electrolytes. Citric acid, trivalent, has extremely precipitating power and so films formed at 20 volts are much thinner than those formed in sulphates. This is typical. Electrolytes containing acid radical of high valence give high critical voltages and films of great specific resistance and high dielectric strength, and thus thinner films are obtained so that less coulombs are required for the formation of the film. This explanation should enable one to find new electrolytes suitable for electrolytic rectifiers and condensers.—*Electrochem. Ind.*, November.

REFERENCES.

Catalysis and Electrolysis.—THATCHER.—An illustrated article giving some examples of catalytic effects in electrolysis. He deals especially with the effect of catalytic agents on the oxidation of a sodium thiosulphate solution with platinized platinum anode, and mentions that poisons, i. e., substances which have a poisonous effect on the human system, also exert an inhibitory influence on reactions in which platinum black acts catalytically. The poison mostly used by him was mercuric cyanide. His examples illustrate the use of catalytic agents in analyzing electrode processes and for practical uses in synthetic electrolyses.—*Electrochem. Ind.*, November.

Storage Batteries.—HOWATT.—An article giving practical rules on the maintenance of storage batteries in electric stations. The author discusses especially the rates of charge and discharge and methods of determining the end of a charge. He considers the hydrometer test and the measurement of the voltage as the only satisfactory ones. He then describes how to deal with such troubles as low cell voltage, reduced capacity, shedding, sulphatation, reversal of negative plates and buckling of plates.—*Power*, November.

Chemical Industries in the United States.—SCHWEITZER.—A long abstract of a lecture on our chemical industries and how to promote them. While the United States is now leading the world in most metallurgical arts and in numerous chemical industries, we are behind Germany in the industries of artificial dyestuffs and fine chemicals. The writer discusses the various points on which the development of a chemical industry depends in a country. He discusses at some length the influence of legislation and urges the abolishment of the internal revenue tax on alcohol for industrial purposes; such alcohol should be denaturalized, i. e., rendered unfit for drinking, by means of the addition of various ingredients.—*Electrochem. Ind.*, November.

Ferro-Alloys.—SCHOLL.—A conclusion of his serial on the methods of manufacture of various ferro-alloys in electric furnaces and the present condition of this industry. The writer deals with ferro-silicon, ferro-chromium, ferro-manganese, ferro-tungsten, ferro-vanadium and ferro-molybdenum.—*Electrochem. Ind.*, November.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Comparison of Small Inductances at High Frequencies.—TAYLOR.—A description of a resonance method for comparing small inductances at high frequencies. The method affords at the same time a determination of the period with fair accuracy. The arrangement of the apparatus is shown in Fig. 2. Let C_1 be a capacity in series

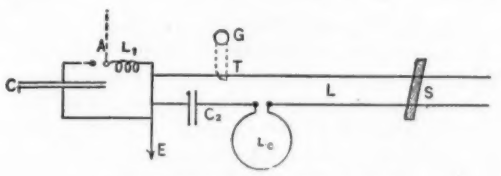


FIG. 2.—DIAGRAM OF APPARATUS.

with spark-gap and the inductance, L_1, while from two points a few centimeters apart on the circuit is run an auxiliary circuit consisting of the capacity, C_2, in series with inductances, Lc and L, and having an iron constant in junction at T. The inductance, L, may be varied by moving the slider, S, until the auxiliary circuit is in resonance with the main circuit, which will be indicated by the maximum deflection of the galvanometer connected with the iron-constant in junction at T. Lc is the inductance which is to be determined. The auxiliary circuit is first brought into resonance with the primary circuit, while Lc is inserted in the auxiliary circuit; then L is cut out and resonance is again established by moving the slider, S, whose position is read on a scale. The change of the inductance of L can be easily calculated.—*Phys. Rev.*, October.

High Temperature Measurements.—A. L. DAY AND ALLEN.—An account of the way in which the high-temperature scale of the Reichsanstalt was reproduced in Washington by means of thermo-couples and melting points. The temperatures were measured with thermo-elements exclusively. The authors used a set of four elements cut successively from the same roll of wire, which, when joined together, proved to be identically alike in their readings over the range of temperature covered by the gas scale of the Reichsanstalt (250° to 1,150° C.), within the limits of observation error. These were taken to the Reichsanstalt and measured in the original melting-point furnace with the same elements in terms of which the gas thermometer scale had been expressed, and five careful comparisons made. These were the melting points of the pure metals, cadmium (in air), zinc (in air), antimony (reducing atmosphere), silver (reducing atmosphere), and copper (in air). The elements were then further compared in an electric furnace and the melting points of the same group of metals again determined in the laboratory of the Geological Survey. The metals used, however, were from other sources than those which had served for the calibration at the Reich-

sanstalt. When this set was finished it was found that, although all the constants in the measuring apparatus—thermo-elements, resistances, standard cells, metals, etc.—had been changed in the transfer from the Reichsanstalt to the Geological Survey at Washington, the aggregate error nowhere exceeded 1° over the entire range from 250° to 1,150°. The following melting points were found by the authors, being given in degrees C.: Cadmium, 321.7°; zinc, 420.0°; silver, 962.2°; copper in air, 1,065.3°, and copper in a reducing atmosphere, 1,083.6°. For everyday use several more thermo-couples were made, of which two were of a new design, which is shown in Fig. 3. This has proved very effective in the determination of melting points of non-metallic substances. The hot junction is protected from the melting charge by a casing of platin-iridium (0.1 mm. thick) and by a protecting tube of refractory Berlin (Marquardt) porcelain (1.5 mm. thick). The new form amounts to nothing more than the ordinary form of platinum—platin-rhodium element with the platinum wire insulated from the other by a very slender porcelain tube and the platin-rhodium wire broadened out and wrapped around this tube like a cap over the portion which dips into the charge. The hot junction is then the lower extremity of the cap, where the platinum wire emerges from its insulating tube and is welded inside the platin-rhodium cap. The electric furnace used was in general design similar to that of the Reichsanstalt.—*Phys. Rev.*, September.

FIG. 3.—MEASURING HIGH TEMPERATURES.

Electric Clock.—An illustrated description of an electric clock, which in principle is a combination of the ordinary type of clockwork with an electrically-operated mechanism which keeps the clock continually wound up. A soft-iron pivoted armature swings between the pole pieces of two electromagnets, and when attracted by the latter assumes a horizontal position, thus stretching a spiral spring. The tension of this spring drives the whole clockwork through a pawl attached to the armature, engaging with a ratchet wheel connected with the gear train of the clock. As the clock runs on, the armature is more and more deflected from the horizontal. When this deflection has reached a predetermined value, a current impulse is sent through the magnets by a special device, and the armature is again drawn back into the horizontal position. To insure continuity during the fraction of a second occupied by this action, the clock movement is driven by a second small spring, which is put under tension by the movement of the armature itself. Two dry batteries are generally employed for furnishing the current.—Lond. *Elec.*, October 7.

REFERENCES.

Selenium for Photometry.—TOWNSEND.—An illustrated description of a series of experiments made to find whether the change of resistance of selenium under illumination may be used for measuring illumination. This would reduce photometry to a simple mechanical process. The main difficulty lies in the fact that selenium is more sensitive to some wave lengths than to others. For this reason it cannot be used at present as a light standard, but may be used for the purpose of comparison between similar lights. For measuring the illumination of a room, however, it is extremely convenient and quite accurate enough.—*Elec. Rev.*, September 10.

Automatic Commutator.—GRAY.—An illustrated description of an improved apparatus for automatically placing a galvanometer in the circuit of a condenser, which was being charged and discharged in rapid succession, just long enough to measure ballistically a single charge or discharge. The apparatus may be employed wherever it is desired to single out for measurement a phenomenon which occurs periodically, provided the intervals between recurrences are not too short.—*Phys. Rev.*, October.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Resonance in Wireless Telegraph Circuits.—PIERCE.—To be enabled to foresee the extent to which confusion may be avoided in the simultaneous operation of a great number of wireless telegraph circuits, it is important to ascertain quantitatively the relative energy communicated between various dissonant circuits compared with the energy communicated between circuits in unison; that is, to ascertain the shape of the curve made by plotting the received energy (or the current in the receiving circuit) as a function of the periods of the two circuits. The writer has measured the relative energy in the receiving circuit for several variations of the capacity and inductance of both the sending and receiving circuit. The measurements show that the phenomena may be made to give sufficient regularity to permit of quantitative study. The results are given in the form of resonance curves obtained under different conditions. These curves show strikingly the necessity of tuning the condenser circuits to resonance with the masts.—*Phys. Rev.*, September.

REFERENCE.

Balancing of Telegraph Cables.—GAYE.—The continuation and conclusion of his long and highly mathematical article on the duplex balancing of telegraph cables. On account of its mathematical nature it cannot be briefly abstracted, but it may be said that the writer not only shows the application of Heaviside's methods to the general problem of a long cable duplex balance, but extends them so as to include the case which had been omitted in the mathematical work both of Heaviside and Hockin, and which deals with the curves of current and pressure entering a cable through both a terminal resistance and capacity. This corresponds to the practical case of the condenser bridge duplex system where it has always been the practice to introduce a differentially adjustable rheostat between the key and condensers.—Lond. *Elec.*, October 7 and 14.

MISCELLANEOUS.

REFERENCE.

Thawing out Frozen Water Pipes.—MAVER.—An illustrated article on the use of electric current for thawing out frozen water pipes. The author describes convenient apparatus for this purpose and gives diagrams and connections.—*Cassier's Mag.*, November.

Improvements in the Valve Mechanism of Air Compressors.

A Grand Prize has been awarded by the Louisiana Purchase Exposition to the Laidlaw-Dunn-Gordon Company, of Cincinnati, who installed the two large compressors located in Block 33, of Machinery Building. One of the machines has a capacity of 1,300 cu. ft. of free air per minute when running at 125 revolutions, and is used to supply the general compressed air requirements of the Exposition, while the other is capable of furnishing 530 cu. ft. and supplies the transportation exhibits. The large machine is fitted with an improved type of valve gear, the distinguishing feature of which is the novel manner of using poppet valves for controlling the opening of the discharge in combination with the semi-rotary, mechanically-moved valves for controlling the closing of the discharge and the opening and closing of the suction.

A mechanically-moved valve of the semi-rotary type is placed in each end of the cylinder, controlling not only the opening and closing of the suction, as in previous designs, but also controlling the closing of the discharge. This valve opens to the discharge early in the stroke, but a series of poppet valves, placed directly over the rotary valve, prevent communication between the interior of the cylinder and the discharge pipe until the compression in the cylinder has reached the discharge pressure. These poppet valves then open and remain open until after the mechanical valve has closed the discharge from the cylinder at the end of the stroke, having a cushion of high-pressure air underneath, and the entire return stroke in which to seat themselves. In this manner the necessity for heavy discharge valve springs, which is the chief objection to the poppet discharge valves, is obviated, and noiseless operation with a minimum amount of air friction is insured, the complete elasticity and simplicity of the ordinary poppet construction being retained. By means of this gear the speed restriction due to the appreciable time required for the seating of the poppet valves is removed, and, as in the case of the steam engine, the only remaining speed restriction is the valve area, which may be proportioned for high efficiency at speeds impossible in a poppet valve machine.

The steam valve of this compressor includes the usual advantages of separate Corliss steam and exhaust ports with small clearance and correspondingly high economy, the Corliss releasing gear, however, with its consequent speed restriction, being eliminated. The small compressor, which furnishes air for the transportation exhibits, is fitted with a semi-mechanical valve gear controlling the opening and closing of the low-pressure suction only. The chief point of interest in this machine is the fork frame construction, involving the use of a solid forged crankshaft, instead of the usual built-up type.

FIG. 1.—GENERAL VIEW OF LEWIS AND CLARK CENTENNIAL EXPOSITION IN ITS PRESENT CONDITION.

Lewis and Clark Exposition.

The attention of the electrical and technical public is directed to the Lewis and Clark Centennial and American Pacific Exposition and Oriental Fair, which is to be held in Portland, Ore., during the summer of 1905. The Exposition will commemorate the centennial anniversary of the arrival of Captains Lewis and Clark and their band on the North American shores of the Pacific Ocean to establish title and explore what was then an unknown region.

When the Exposition opens its gates on June 1, 1905, it will represent an expenditure of $5,000,000, part of which is to be furnished by the United States Government. The location chosen for the Exposition consists of 190 acres of land on a lake of nearly 300 acres in surface area, situated in the northwestern part of the city near one of the best residential districts. The ground is in two pieces, separated by the lake, and they will be connected by an arched bridge. On the side nearest the city there are over 130 acres of rolling ground, which reaches an elevation of over 100 ft. above the level of the lake; on this portion are erected the main buildings, many of which are nearing completion. Here also is located a park of about 50 acres, covered with many large evergreen trees and native shrubs.

Across the lake is a peninsula of about 60 acres, on which the Government buildings and exhibits will be placed. This peninsula will be connected with the mainland by a bridge 2,000 ft. long, which will be the Midway or Pike of the Fair, and will be called the Trail and Bridge of Nations. On each side of the bridge for about 900 ft. the concessions will be located, the remaining 1,100 ft. being taken up with arched construction. The bridge will end at the main entrance of the Government Building, and besides being a unique feature it will afford a grand view of the Exposition grounds and of the surrounding and distant scenery, which cannot be surpassed. For a background there are timbered hills rising several hundred feet, while to the eastward lies the Columbia River Valley, with the Cascade Mountain Range for a boundary, in which are seen Mounts Jefferson, Hood, Adams, St. Helens and Rainier, all covered with perpetual snow, while between the Exposition grounds and the mountains flow the Willamette and Columbia Rivers. On these may be seen at all times numerous deep-water craft and inland steamers.

Transportation to the grounds will be furnished by the lines of the Portland Railway Company and the City & Suburban Ralway Company. Both have recently built additional tracks to the grounds, and have also been relaying their roads with heavier rails in order to take good care of the traffic during the Exposition. The systems of the two companies are so arranged that each has the use of two sets of lines running on different streets, but coming together in

FIG. 2.—SKETCH OF LEWIS AND CLARK CENTENNIAL EXPOSITION, PORTLAND, ORE.

the center of the city at the principal transfer points, so that the street railway service will be equivalent to four distinct lines to the grounds. Long before the Exposition opens, the recent consolidation of the two railway companies to form the Portland Consolidated Railway Company will be effective, and comprehensive arrangements will have been completed for the expeditious and harmonious handling of the Exposition traffic. A double-track, one-way loop at the main entrance will be used by all the lines centering there.

The grounds, buildings, bridge and park will be illuminated with incandescent lamps. All buildings will be outlined, 8-cp frosted lamps being used for this purpose. The roadways and bridge will be illuminated from post electroliers, as also will be the boulevards along the lake. The park will be lighted by 7,000 incandescent lamps. These will be placed among the trees and shrubbery and along the paths and walks.

It is the intention of the management to decorate many of the large fir trees in the park, and, as some of them are over 200 ft. in height, the effect produced will be impressive. The Government Building is designed in the Mission renaissance style. On each end of the main structure there will be an electric tower 260 ft. high. The ends of the main building are flanked by peristyles connecting smaller structures.

The Midway or Trail, built over the water, will present an unusual construction, and its brilliant lights, together with the great amount of illumination on the lake, will make the scene a most attractive one. The design and supervision of the electric installation is under the direction of James R. Thompson. Current for the lighting and power of the Exposition will be furnished by the Portland General Electric Company from a new steam turbine plant which is building near the grounds to supplement the power received from the company's water power plant at Oregon City. The principal exhibit buildings are already under roof, and are prepared for the storage of such exhibits as may be shipped from St. Louis at the close of its Fair.

Henry W. Goode, president of the Portland General Electric Company, is president and director-general of the Exposition; Henry E. Reed is secretary and director of exploitation and publicity, and Oscar Huber is director of works.

Timber Preserving Plant at the Exposition.

The rapid destruction of the great forests of this country has forced upon the railroads a very serious problem in connection with the supply and preservation of timber and outdoor construction, especially ties. Since the supply of timber for this purpose will probably decrease as time goes on, many efforts have been directed to perfecting processes to preserve the ties from insects and decay. The Ayer & Lord Tie Company, Chicago, has erected a number of large plants for this purpose in different parts of the country and has placed on exhibition at St. Louis, west of the California and South Dakota gold mine exhibits, between Intramural Railway Stations 12 and 13, a model plant, capable of doing commercial work. The timber being treated is placed in air-tight cylinders, where it is first subjected to steam under pressure to remove all air from the pores of the wood, after which the air and steam are exhausted. For producing a vacuum, a Deane single-cylinder, horizontal, direct-acting, wet vacuum pump is used, in which the piston rod stuffing box and the piston are submerged. After all vapor and gases are removed, creosote is pumped into the tank and forced into the wood by pressure. The pressure pump in this equipment is designed to work against 300 pounds pressure per square inch, and is of the Deane duplex type, with double plungers instead of pistons. The advantage of the plunger type of pump is that the packings are on the outside, where leakage is immediately detected.

A single-cylinder, fly-wheel air compressor, having a 6-in. steam cylinder, a 6-in. air cylinder and a 6-in. stroke, is next used to force air into the tank, displacing the creosote and returning it to an elevated storage reservoir. This machine was built by the Clayton Air Compressor Works. The air cylinder of the compressor is completely water jacketed, both on the sides and heads, and the valves and seats are self-contained and removable. The fly-wheels are extra heavy, so that the machine will operate satisfactorily at very low speed, if necessary.

Report on the Wireless Telegraph Communication Between St. Louis and Chicago.

On the 14th of September a series of wireless telegraph tests were made between the St. Louis Exposition and the city of Chicago, which, while not the longest overland transmission tests which have thus far been made, were nevertheless the most important land tests yet made.

The De Forest Wireless Telegraph Company, which has ten outfits and seven operating stations at the St. Louis Exposition, had succeeded in successfully signaling between their station on the Exposition grounds at St. Louis and the city of Springfield, a distance of 103 miles, and subsequent tests led them to believe that it was possible to successfully maintain communication with Chicago, a distance of upward of 300 miles.

After certain preliminary tests they were on the point of officially opening the communication between these two cities, when Prof. Goldsborough, chief of the Department of Electricity, requested that they should defer this for a few days until the 14th of September, this being "Electricity Day," and he called upon the Group Jury 71, that on "Telegraphy and Telephony," which embraced automatic telephony and telegraphy, automatic telephone exchanges, wireless telegraphy, wireless telephony, etc., as well as the general

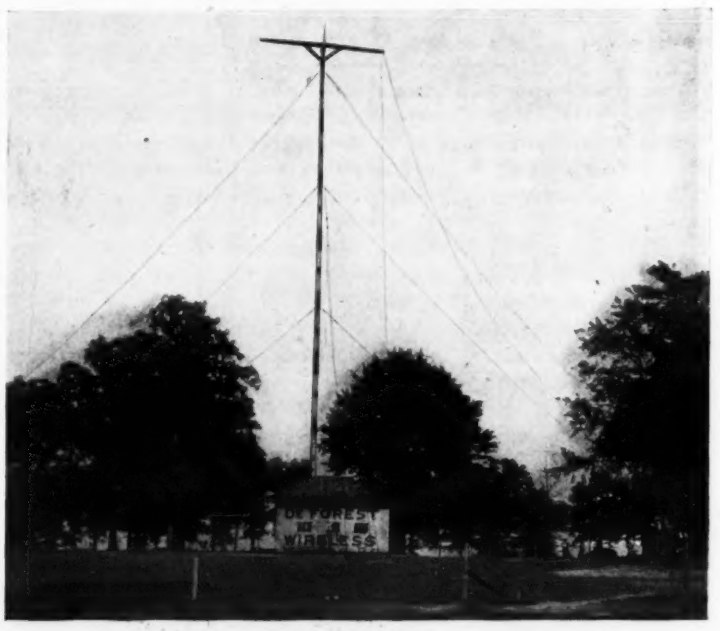


FIG. 1.—WIRELESS STATION.

fields of telegraphy and telephony, requesting that they should take official cognizance of the tests made on Electricity Day, and thus identify themselves with the programme of the day.

The jury, after carefully considering the matter, decided that if the entire tests were placed in the hands of the jury they would arrange a series of tests to be carried out on this occasion, and that these tests would constitute part of the official work of the jury, and thus affect any decision they might make regarding the awards given in this class.

The necessary arrangements were made and the chairman of the jury, Mr. William J. Hammer, of New York City, and Prof. James C. Kelsey, of Purdue University, went to Chicago to take charge of the station at that city. The names of the other members of the jury who remained at St. Louis were Mr. Gaston Roux, of Paris, vice-chairman; Prof. A. S. Langsdorf, of Washington University; Dr. A. E. Kennelly, Harvard University; Dr. F. Benedict Herzog, New York, and Mr. A. I. de Costa Couta, of Brazil.

The members of the various other group juries in the Department of Electricity, and the members of the International Electrical Congress, were invited to be present at the St. Louis end and witness the tests.

Although the members of the jury had little doubt, as a result of their investigations, of the ability of the De Forest apparatus to successfully transmit messages to Chicago, they were aware that certain doubts had been expressed of the success of the transmission of messages to Springfield, which is only about one-third of the dis-

tance, and realizing that there would perhaps be the suspicion in many minds of a possible collusion between the wireless operators and the telegraph and telephone companies, they endeavored to arrange a series of tests which should demonstrate beyond peradventure the success of the test messages.

The following were among the tests which were made and which seemed to the members of the jury and to others present as quite conclusive.

Mr. Hammer, the chairman of the jury, before leaving for Chicago, wrote out a message in duplicate, both copies of which he sealed up, taking one with him and leaving the other with the vice-chairman, Mr. Roux, the latter copy to be opened only when Mr. Hammer gave the signal from Chicago.

Arrangements had been made to give the jury control of the long-distance telephone line between the mast at the Exposition grounds and the mast on the lake front at Chicago for a period of three hours, and on Mr. Hammer giving the signal from Chicago the message was opened in the presence of the jury and handed to the operator. The time was taken with five stop watches at both ends of the line, which had been set and compared over the long-distance telephone, and immediately upon receipt of the message at Chicago it was telephoned back to St. Louis. Attention was called to the fact that the word "indissolubly" had been left out of the message, and the answer came back that this had been purposely omitted as an additional test. The message, which was otherwise exact, took three minutes in transmission and was as follows:

"The names of Faraday, Hertz, Branly, Popoff, Lodge, Muirhead, Marconi, Tesla, Edison, De Forest, Dolbear, Braun, Fessenden, Slaby, Arco, Rochefort, Shoemaker, are among those names indissolubly connected with the principles and the applications of wireless telegraphy."

At the Chicago end of the line, in addition to the two members of

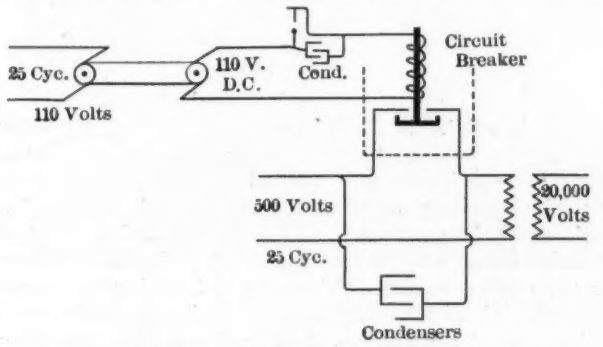


FIG. 2.—DIAGRAM OF CIRCUITS.

the jury and the operators of the De Forest Company, were representatives of the telegraph and telephone interests, the technical and daily press. While the success of this test was admitted, the question was brought up as to whether it would not be possible to use the wireless system and the Morse telegraph system together, transmitting the message from the Exposition grounds to the suburbs of St. Louis by wireless telegraph, a repeater taking it up at this point and transmitting it by Morse over a telegraph line to the suburbs of Chicago, where a repeater would transmit it in wireless across the city of Chicago to the station on the lake front.

This very point had been brought up before the jury at St. Louis, and it was decided that even supposing such a system to have been developed and perfected, it would not have been possible to have transmitted the message in any such space of time as this particular message and others were transmitted.

As a second test the chairman left one of two copies of a book which he had received from a Japanese member of another jury at St. Louis, taking the second copy to Chicago with him. These books were printed partially in English and partially in Japanese. He then telephoned to St. Louis asking them to send him a cryptogram. They sent the signal 3-15, which meant, "Turn to page 3, begin on the 15th line and read the rest of the paragraph."

The time was taken and the operator at St. Louis immediately despatched the paragraph selected. The chairman then telephoned the message back from Chicago, calling attention to the fact that certain words had been eliminated, and received the reply that this was correct, and that the words omitted had been purposely eliminated as a further check.

The third test was one which did not require an expert operator at either end of the line.

Mr. Hammer telephoned from Chicago, asking that the operators be eliminated from the St. Louis end and that one of the members of the jury should send some Morse character over the line a definite number of times. He in the meantime sent the two De Forest operators away from the Chicago end of the line, Prof. Kelsey and himself placing the receivers to their ears readily receiving the Morse character sent, which was that of the letter "d," consisting of a dash and two dots, which was repeated about a dozen times.

After these tests were completed Prof. Goldsborough sent a message to the representatives of the De Forest Company and many other messages were transmitted to the Governor of the State, the Mayor and to private parties.

At the time of the official tests it was only possible to transmit messages from St. Louis to Chicago, as no facilities had been then arranged for transmitting from the Chicago end, but regular paid

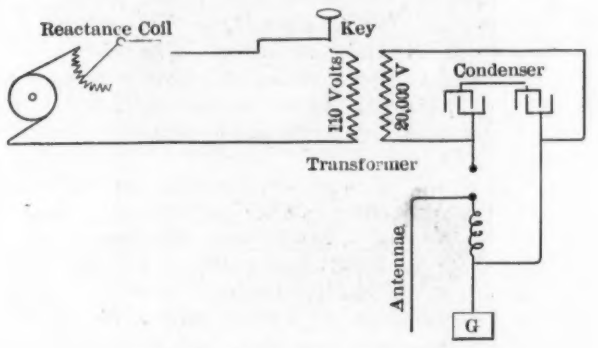


FIG. 3.—DIAGRAM OF CIRCUITS.

service is now maintained at the World's Fair station with Springfield, Ill., and Chicago. The De Forest Company advertises in the daily papers a regular service at regular Western Union rates. This is the first time that such service in competition with land lines over any distance whatever has been given the public by wireless telegraphy, and can be considered a most notable and significant advance fully in keeping with the progress signified by the St. Louis Exposition. It is especially appropriate that a formal opening of this importance should have occurred on Electricity Day before the presence of the International Electrical Congress.

Ticket Office and Toilet Room Heaters for the New York Subway.

For the heating of the ticket offices of the New York Subway the engineers of the Interborough Rapid Transit Company decided to adopt a special heater submitted for their consideration by the

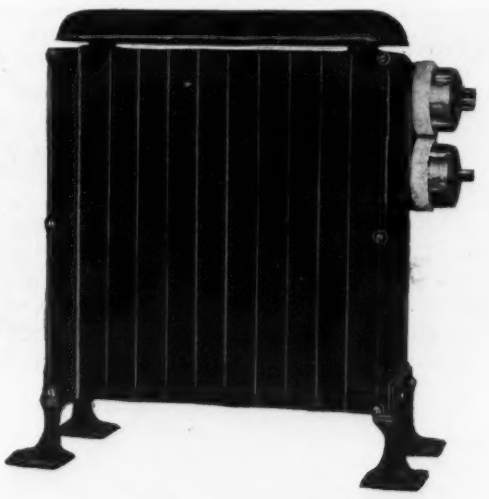


FIG. 1.—HEATER.

Prometheus Electric Company, which is shown in Figs. 1 and 2. Fig. 1 shows the exterior of the heater and Fig. 2 the internal construction of the device.

The heater consists essentially of a cast-iron box supported on two sets of legs, the box being 16 in. wide, 17 in. high by 4½ in. deep. As will be seen in Fig. 2, the air is admitted through the bottom

of the heater, which contains a number of openings, and escapes, after being heated, through an opening at the top of the heater, which is covered by an iron canopy, leaving an air space of 1 in. between the box and the canopy. To prevent any possible overheating of the box which might cause scorching of clothing, a number of slots are provided on the back of the heater to facilitate the escape of heated air.

Two 500-volt, 10-amp. switches are mounted on a special support at one end of the heater and by means of these switches one-half of the full heater equipment of each heater may be used. A ribbed plate is attached to the front of the heater by means of screws and by simply taking off this plate the interior of the heater may be inspected, as shown in Fig. 2. The electric equipment proper consists of 8 iron-clad Prometheus heating units supported on blocks of porcelain, which are attached by means of studs to the back of the box.

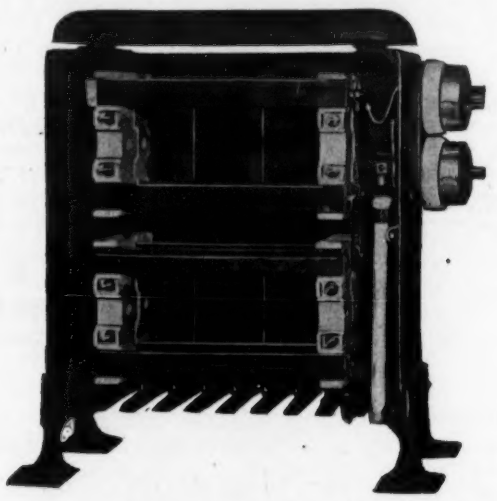


FIG. 2.—INTERIOR OF HEATER.

The main circuit wires leading to the heater are passed through a special porcelain bushing and a porcelain tube at the one end of the heater, as shown, where they are connected to copper lugs. So simple is the construction of the heater that the entire electric equipment can be taken out and replaced in ten minutes.

The Prometheus units each have a capacity of 100 watts, so that the total capacity of the heater is 800 watts. Each unit is 1¼ in. wide by 12 in. long by ⅛ in. thick, and the construction of the same has frequently been described in our pages.

The heaters which have been adopted for use in the toilet rooms are shown in Figs. 3 and 4, the former showing the front of the heater and the latter the back of the same. These wall plates, which measure 14 in. by 28 in., and which are finished in dull nickel, are attached to cast-iron boxes, built into the wall, in such a manner that after the heater is in place the front of it is flush with the slate covering of the walls.

FIG. 3.—FRONT OF WALL PLATE.

The electrical construction of these heaters is similar to that of the ticket office heaters, the same parts being used for both types of heaters. A number of these wall heaters are equipped with six iron-clad units, giving a total capacity of 600 watts, and another set of plates is equipped with four units having a capacity of 400 watts. There are four of these heaters in each toilet room, and they are controlled by switches in such a manner that the heaters may be turned on and off in sets of two, or one-half of each heater may be used at any one time in conjunction with one-half of any other heater. The plate being of the grid pattern permits of a thorough circulation of the air, preventing the overheating of the plate.

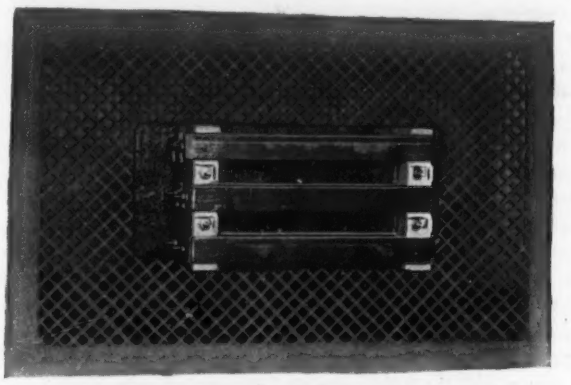


FIG. 4.—BACK OF WALL PLATE.

These two types of heaters were specially designed for the Interborough Company by Mr. Max Loewenthal, electrical engineer of the Prometheus Electric Company.

Bullock Exhibits at the St. Louis Exposition.

From an engineering standpoint the exhibits made by the Bullock Electric Manufacturing Company at the World's Fair are as complete and instructive as any ever made by a manufacturer. As may be noted from the illustration, the immense space is well filled with electrical machinery, and this has been so carefully arranged and connected that every item can be operated. The distinctive feature of the whole exhibit is the equipment for testing which has been used to great advantage by the Electric Railway Test Commission. A series of experiments were carried on to determine the various effects of alternating currents flowing through steel rails. The Bullock motor-generator was the only set which could furnish frequencies from 10 to 70 per second. A series of tests have been made upon the reactance in the rails and getting the temperature coefficients. These tests are made by taking the resistance of the rail at a normal temperature, then passing a large enough current through the rail to raise its temperature through a range of 30° C. and at various stages of heat making other tests. There seems to be but little difference in the resistance at the various temperatures. It has been suggested that this may be due to the presence at the same time of iron and carbon in the steel, the one losing in conductivity while the other gains with the rise of temperature. So far the drop in voltage has been found to be much smaller with direct than with alternating current, while it varies much with the variations of current density and saturation. Valuable information was thus derived from the use of the Bullock apparatus, and the results in full will be published when the report to the Electric Test Commission is made.

In other respects the exhibit of electrical machinery is very fine and in keeping with the importance of the company and its ambition to become one of the very foremost institutions of its kind in the world. Since its absorption by the Allis-Chalmers Company, of Milwaukee, large plans have been formed for extending the scope and importance of its business. Motors, generators, balancing sets, transformers, traction outfits, etc., comprise the big display and the machines are shown not only in operation but with parts removed so as to show construction.

Among the motors are ten of the Bullock type B from 1 to 35 hp, designed and constructed to meet the demand for small motors which will withstand hard usage successfully for power purposes in general. They are of the wholly enclosed or open type and designed so that they may be operated on floors, sidewalls or ceilings. Types "N," "ND" and "NI" meet the requirements of a motor where severe overloads and long runs at a low temperature are necessary. They are particularly adapted for machine tool driving, and are shown in connection with the Bullock multiple voltage system and balancing sets and small direct-connected lighting units. They are

of the open and wholly enclosed type, and operate at 300, 600 and 900 r.p.m. The "ND" type is provided with back gearing. In the exhibit of multiple-voltage balancing sets there are shown three machine tools equipped with the Bullock multiple-voltage, three-wire system of variable-speed motors. By this system motors may be operated up to 700 per cent. variation in speed forward or reverse, and with all intermediate speeds. These machine tools are always under the control of the operator and may be run at the speeds best adapted for their work. This system embodies many features of special advantage, and experience has demonstrated that it will increase the output of a tool from 20 per cent. to 40 per cent. Another exhibit shows an "N" multiple-voltage balancing set for operating machine tool motors. By its use there can be furnished currents of 90, 160 or 250 volts, so that motors may be operated over a range of speed of 700 per cent., or even greater, if necessary.

The 12-kw type "B" lighting balancer is another machine on this space. These sets are intended to take care of the unbalanced load of the three-wire lighting circuit, and are automatic in their action, taking but little space and requiring almost no attention.

In transformers there is a Bullock 250-kw, 2,300 to 20,000-volt, single-phase, 60-cycle transformer, which is typical of the high-potential transformers built by this company in sizes from 50 kw upward. Two other items are the 150-kw Bullock oil-filled, self-cooling transformer core and winding, one complete and one incomplete, showing the simplicity of construction, the neat design and the careful insulation.

In generators there is an "A. H." Bullock alternator, with parts removed to show construction, also the "IT", 200-kw Bullock twin electric generator, driven by a 300-hp De Laval steam turbine. These outfits are built in various capacities up to 200 kw for all standard voltages, both alternating and direct current.

The generators consist of Bullock belted type, 2,300-volt, 60-cycle, three-phase alternators with capacities of 50, 75 and 150 kw. These machines are of the rotary field type and can be operated at full load 24 hours a day with a rise in temperature not to exceed 35°. A 225-kw, 2,300-volt, three-phase, 60-cycle, 600-r.p.m. alternating-current generator with direct-connected exciter is typical of a line of engine-type, alternating-current generators, which the company builds up to any practicable size. The 5,000-hp Allis-Chalmers engine, in Machinery Hall, is direct-connected to a 3,500-kw, three-phase, 25-cycle, 6,600-volt Bullock generator.

A small generator of 10-kw, 120-volt, 83-amp., 500-r.p.m. is direct-connected to a Reeves high-speed, automatic compound engine and this type is built in capacities from 3 kw up. Two other generators are one of 75 kw, 230 volts, 312 amp., 830 r.p.m. and the other a 100-kw, 230-volt, 416-r.p.m., which the company builds in various capacities from 7½ kw up, either belted or direct-connected, and for all standard voltages.

A motor-generator outfit consists of a 2,300-volt, three-phase, 60-cycle, 600-r.p.m., direct-connected 500 to 550-volt, 409-amp., direct-connected generator, with direct-connected exciter. A Bullock 500-kw, three-phase, 25-cycle, 500-r.p.m. rotary converter is shown which is built in sizes from 100 to 1,000 kw. There are three 150-kw, oil-filled, self-cooled transformers, transforming from 300 to 400 to 6,600 volts, single-phase, 25-cycle. Several induction motors are shown, including a ½-hp, 220-volt, three-phase, 60-cycle, 1,100-r.p.m. machine which the company builds in all sizes up to 500 hp.

In traction equipment there is a particularly complete display and as this company is the latest manufacturer to place street railway motors and controllers on the market they are of the latest and most perfect design. Two 50-hp street railway motors are mounted on trucks and ready to operate, besides a motor shown with the casing open and the style of construction exhibited. These motors are marked by their large commutators, which are well ventilated, and by a superior design and construction of the armature and fields. The Bullock exhibit as a whole proves very instructive and interesting to electrical men whether connected with light power or street railway properties.

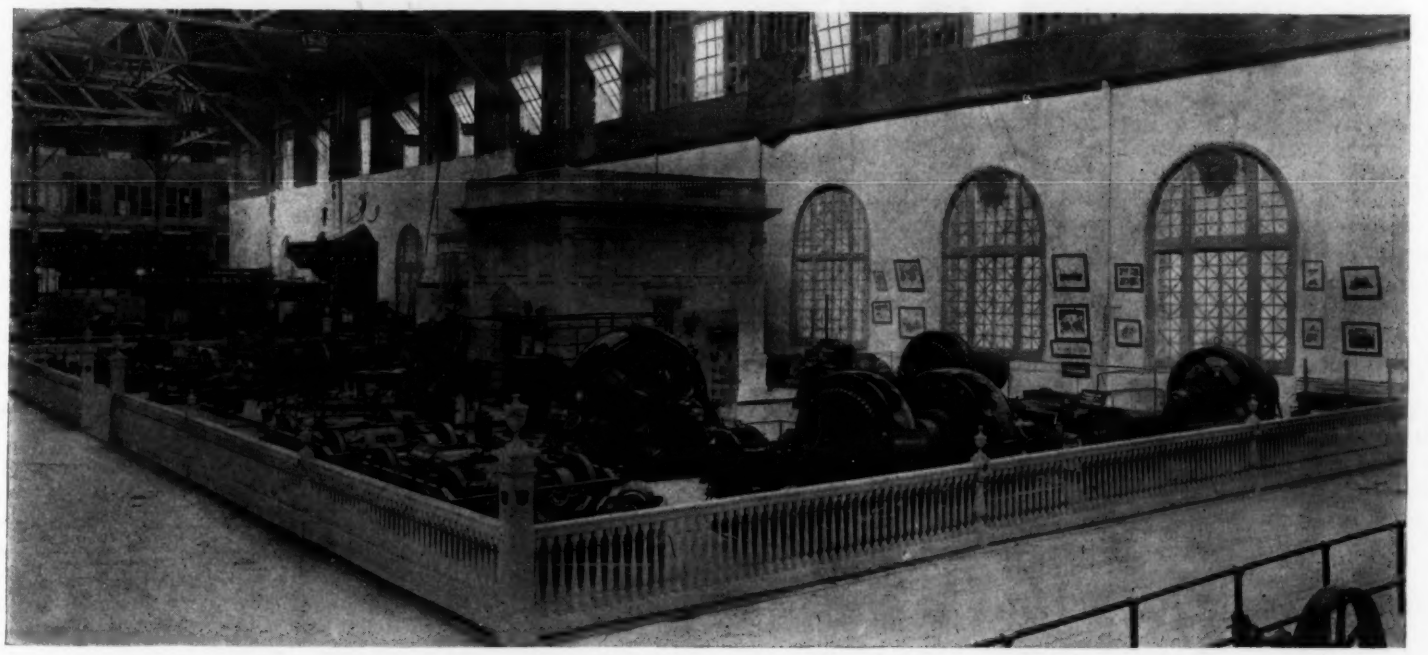


EXHIBIT OF BULLOCK ELECTRIC MANUFACTURING COMPANY.

Hydraulic Relief Valves.

The Lombard Governor Company, of Boston, Mass., has recently developed and put upon the market a new type of hydraulically balanced relief valve, the utility of which will be readily appreciated by all who have had anything to do with water power plants. This valve, as shown by the lettered diagram, consists of the following parts, viz: A valve disc, *c*, capable of motion to or from its seat, *b*, rigidly connected by means of a rod, *i*, with the piston, *f*, in the cylinder, *e*. The whole valve is bolted to a flange upon the supply pipe, *d*, wherein the pressure is to be controlled. The area of piston, *f*, is somewhat greater than that of the valve disc, *c*, so that when water at the same pressure is behind the piston and in front of the valve there is a positive and strong tendency to hold the valve closed. For the purpose of allowing the valve disc, *c*, to open at proper times to relieve excess pressure in the supply pipe, *d*, there is provided a regulating waste valve, *C*. This valve is opened or closed by a piston, *n*, opposed by a very long and strong spiral spring, *p*. Piston, *n*, is a loose fit in its cylinder, *o*, so that it moves upward freely in response to the least excess in pressure upward due to the water in the cylinder, *o*, opposed to the downward pressure of the spring, *p*. The piston with its spring resembles in its action the well-known steam engine indicator, which is universally used to follow and record quick pressure changes occurring in the cylinder of the steam engine. The piston, *n*, is connected by means of the stem, *m*, with a double-seated balanced valve, *d*, which of course opens simultaneously with any upward movement of the piston. Water under existing pressure is admitted into the cylinder, *e*, through the pipe, *k*, and throttle valve, *l*.

The spring, *p*, is adjusted by means of the screw, *s*, and lock-nut, *y*, so that the effective normal pressure of the water in the chamber is just insufficient to overcome the downward pressure of the spring. The valve, *D*, will, therefore, remain closed normally; consequently the main valve disc, *c*, will also remain closed normally, because water flowing in through the pipe, *k*, and throttle valve, *l*, will produce an excess closing pressure upon the piston, *f*. When thus adjusted any increase in pressure above the normal will immediately force the piston, *n*, upward, and will thereby open the balanced valve, *D*. This instantly relieves the pressure back of the piston, *f*, which of course then gives way to the superior pressure in front of valve, *c*. In this manner practically the whole pressure in front of the valve disc, *c*, is available for opening it, an important fact when it is realized that corrosion between a valve and its seat sometimes occurs. Valve disc, *c*, will continue to open until the limit of its travel has been reached, or the pressure in the supply pipe, *d*, has been reduced to a point where the piston, *n*, will close the balanced valve, *D*. Immediately on the closing of balanced valve, *D*, water begins to accumulate behind the piston, *f*, flowing in through the throttle valve, *l*. This water gradually and surely forces the valve disc, *c*, to close. The speed of closing is adjustable by the opening through the throttle valve, *l*, and may be made as slow as several seconds or even minutes. The closing motion is perfectly uniform and there is not the slightest tendency to set up vibrations in the water column, a very serious objection to the ordinary types of spring balanced valves which open and close suddenly and are liable in the latter operation to set up water hammer effects even more dangerous than those which they are designed to relieve.

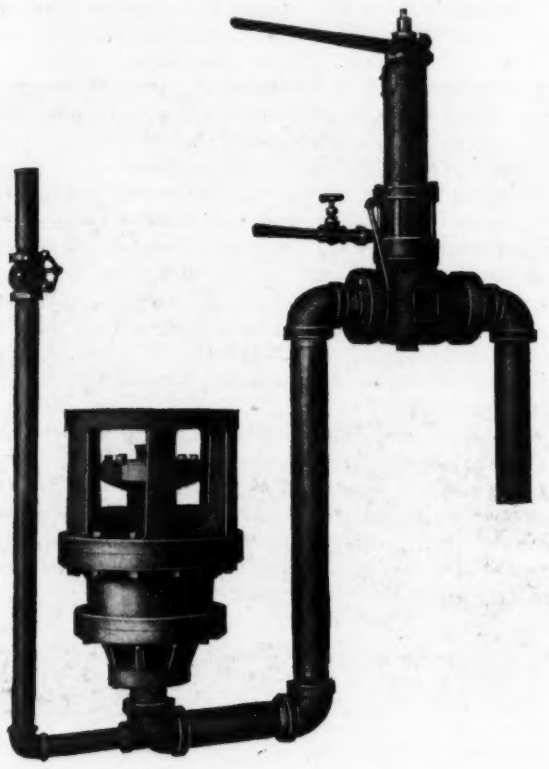


FIG. 1.—HYDRAULIC RELIEF VALVE.

In connection with the action of the hydraulic valve it should be noticed that closing takes place at almost the same pressure as that which causes opening, because the excess pressure of the piston, *f*, in closing is great enough to overcome the impact effect of the flowing water striking against the front of the valve disc, *c*. With spring balanced relief valves there is a very strong tendency for the valve, when once opened, to remain so. While such action is neither very objectionable nor marked in the case of steam, it is extremely undesirable with water. If a relief valve on a supply pipe to a turbine does not open for a rise in pressure of 2 per cent. or 3 per cent. above the normal, the increased pressure is liable to react upon the turbine itself, causing a variation in speed greater than would otherwise be the case. This is entirely apart from any danger of bursting of wheel case or penstock. If, however, it should be attempted to adjust a spring balanced relief valve to open at 2 per cent. rise of pressure above the normal such a valve would never close, because it would still remain open when the pressure had fallen to the normal, due to the impact of flowing water against the open valve. It might be necessary to set such a valve to open at a pressure as much as 10 per cent. or 15 per cent. above the normal in order to be sure that it would close again when the pressure returned to its usual value. With the valve illustrated, it is a perfectly simple matter to make such an adjustment that the opening will occur at 1 per cent. above normal and still permit the valve to be closed at the ordinary pressure.

Engineers have recognized for many years the need of protection against sudden rise of pressure due to changes of velocity in long water columns. The most common means employed for this purpose in the past has been the standpipe, which is simple, sometimes inexpensive, and usually reliable. Whether the standpipe or hydraulically balanced relief valve is better for any given location depends upon the conditions, which must be carefully considered in certain cases. In general, it may be stated that a standpipe of ample dimensions is the most economical means of taking care of pressure changes under low hydraulic heads, particularly in warm climates. For high heads a standpipe is usually not only more expensive, but less safe, due to the inertia of the water which it contains within itself. Where there is liability of freezing, a standpipe is unreliable, but it is easy to protect a relief valve from frost by locating it within a building or under ground. For pressure heads exceeding 150 ft. a standpipe is usually out of the question, owing to the great cost of building a structure sufficiently high and strong to stand the weight of the water and the pressure of the wind. Hydraulic relief valves can be furnished at slight extra expense over the standard design to operate under pressure exceeding 1,000 ft. of head.

In mountainous countries water power is almost always developed by supplying the wheels from very long feeder pipes working under great pressure. Here the need of relief valves is imperative if it is attempted to regulate speed by increasing and diminishing the flow of water. The common spring balanced relief valves are so unreliable that no satisfactory results have been obtained from their use under such severe conditions. In consequence, the well-known deflecting nozzle has been used, which wastes at any instant all the water not needed to carry the load. It is believed that with the advent of the valve described herein a serious attmpt will be made by managers of power plants to economize water through the adoption of tangential wheels with needle nozzles and high head turbines, which can show much higher average efficiency than deflecting nozzles.

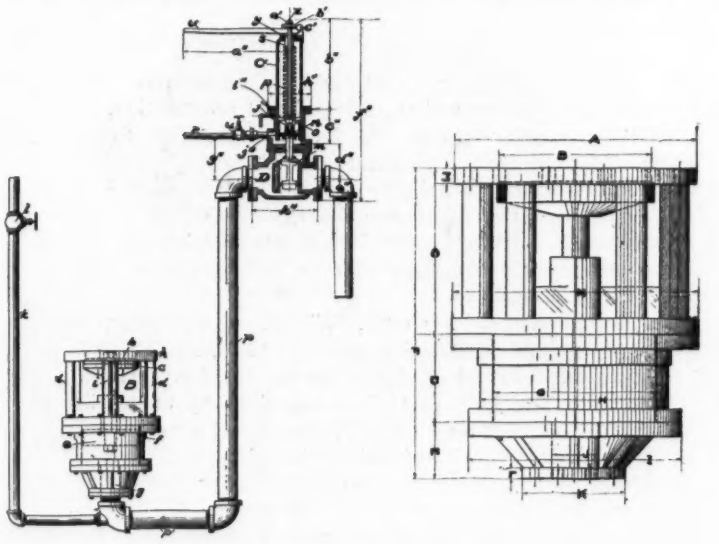


FIG. 2.—DIAGRAM OF VALVE.

These hydraulic relief valves are generally furnished for open discharge; that is, to throw the water directly away from the valve into the air space surrounding it. The discharge takes the form of a hollow cone with the valve as its apex. A circular casing of masonry or sheet iron is often provided to confine this cone of water and carry it away. It is not desirable to submerge the valve, because the effective discharge is thereby lessened, but submersion will not prevent the proper operation.

Century Single-Phase, Alternating-Current Motor.

Among the inventors who have taken a leading part in the development of motors for single-phase, alternating-current circuit, is Mr. E. S. Pillsbury, several types of his invention having entered into wide use. The special features of one of his earlier types consisted in combining a progressively-wound armature with a slot-wound field, in such a manner that it started as a series motor; after the machine had acquired the proper speed, the brushes were moved away from the commutator, connected together and simultaneously the winding on the armature short-circuiting, after which the motor ran purely as an induction motor. These motors were also provided with

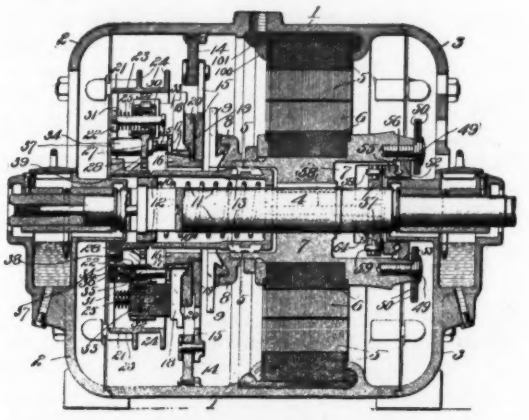


FIG. 1.—LONGITUDINAL ELEVATION OF SINGLE-PHASE MOTOR.

a short-circuited winding on the rotor to prevent it from going above synchronism in case the operator failed to throw the lever at the proper time. The field windings were applied in such a manner that the magnetic lines of force were more intense at the center of the pole than at either side, decreasing in strength as they approached the ends, which points were practically neutral. In this manner a symmetrical field was attained, making the magnetism of the poles intense at the proper point. The slot into which the winding was laid served the double purpose of enabling the distribution

FIG. 2.—SINGLE-PHASE MOTOR.

of flux as described to be attained and in preventing the distortion of the field caused by the reaction of the rotor on the stator, which tended to drag the flux to the horn of the pole piece.

Later, patents were granted to E. S. Pillsbury and F. Schwedtman on an improved type of single-phase motor, the new features consisting in the construction and arrangement of a centrifugal device and its associated parts, for electrically connecting the brushes, short-circuiting the commutator and removing the brushes from the commutator; in the construction and arrangement of the field core supports and in the mechanism employed for adjusting the same. In this motor the windings were practically the same as those employed in the machine previously described, except that the closed coils on the armature being unnecessary were abandoned, the winding being a plain multipolar progressive one. On throwing the main line switch the motor started as a series motor as described above, and after attaining the proper speed, by means of the centrifugal arrangement, the commutator was short-circuited, the brushes thrown away from the same and electrically connecting, after which the machine operated as an induction motor.

This type of motor was later still further developed by Mr. Pillsbury, the new features consisting in a superior design of frame and method of adjusting field core in same; in a novel form of governor weights and mechanism whereby motion was transmitted for throwing of the brushes, short-circuiting commutators, etc.; in the brushes being in electrical connection at all times; in bearings forming part of the end plate and in a new method for adjusting the spring which determines the speed necessary, all to operate the gov ernor weights or the synchronous speed.

At the present time Mr. Pillsbury is associated with the Century Electric Company. During his connection with this company he has developed his latest type of motor shown in Fig. 1, patents on which were granted him in September, 1904. The principal object in this design is to secure a more efficient machine, and with this point in view it is so constructed that in starting, instead of the secondary current induced in the armature or secondary member being commutated, the current supplied to the field or primary member is commutated. This makes it possible to employ larger and heavier conductors in the armature or secondary member in place of the fine wire conductors heretofore employed, the armature thus being rendered more substantial, of lower resistance and smaller self-induction, and it will carry a greater load than an armature provided with the fine wire windings. The armature is thus less susceptible to changes in frequency and capable of withstanding a greater overload.

The general principles involved in the field and armature windings in the machine above referred to are similar, except in the size of conductors as noted. In the previous types of four-pole machines the brushes served to connect the armature windings at four points 90° apart, while in this machine the same conditions are brought about by permanent connections to the windings.

Referring to Fig. 1, a reproduction from the patent specification,

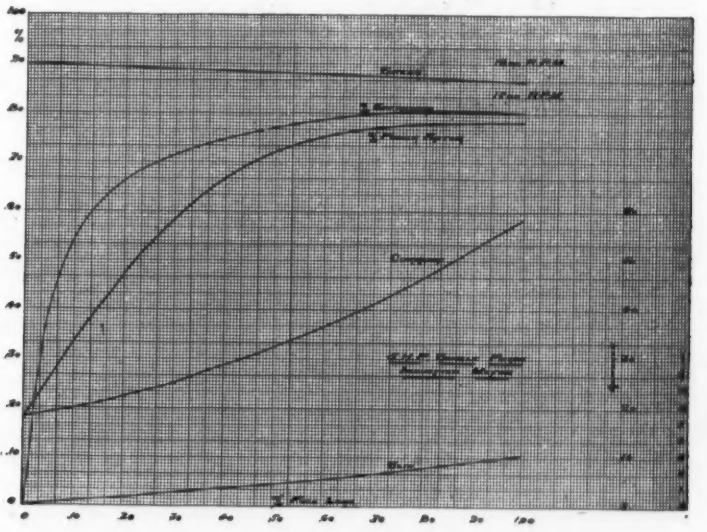


FIG. 3.—EFFICIENCY AND POWER FACTOR CURVES OF SINGLE-PHASE MOTOR.

after this motor has attained the proper speed the governor weights, 50, operate a cam, 55, which transmits motion for throwing off the brushes and short-circuiting the commutator on the armature, and at the same time making four connections in field coils diametrically opposite. Fig. 2 shows the general appearance of this motor as it is being made at the present time, and in Fig. 3 are given curves plotted for a 5-hp machine showing the efficiency and power factor, current consumption, speed and slip.

In the development of this motor a fact never lost sight of is that in addition to a high efficiency there is also a growing demand for machines simple and substantial in mechanical construction. With this point in view the Century Company has in the commercial type of machine departed somewhat from the details shown in Fig. 1.

Renewing Burnt-Out Lamps.

The Dwyer Machine Company, of Lynn, Mass., has for some years made a specialty of manufacturing the apparatus and developing the processes used in incandescent lamp manufacture, and now announces that it has perfected a machine for refilamenting or renewing burned-out lamps, which makes it practicable for the large users to do their own renewing and effect a considerable saving. Following are statements of the claims made for the new system:

Four girls, such as average a dollar a day in lamp factories, under the supervision of the station electrician, can renew 500 lamps a day. Less than a mechanical horse-power is required and about ½ kw of current, and as most stations already have measuring instruments all that they need add to their repair shop are the machine, a few small tools and trays for handling the work.

Refilled lamps, of course, are nothing new, an account of Mr. Dwyer's system having been published in these columns in September, 1896. The actual date of invention, by the method now generally used, dates back to 1891, and to his invention of the paste cement for attaching the filaments to the wires and which is now used in the manufacture of practically all lamps.

Methods have been so perfected that all but about three per cent. of the lamps can be brought within the range of voltage or candle-power usually shipped on an order (i. e., on the practice of the larger companies) for one voltage and one candle-power. To simplify the operations as much as possible, the company proposes to furnish the carbons all ready to mount in the bulbs. With the filaments furnished, the process reduces itself to pasting the filament in position and cleaning and exhausting the bulb.

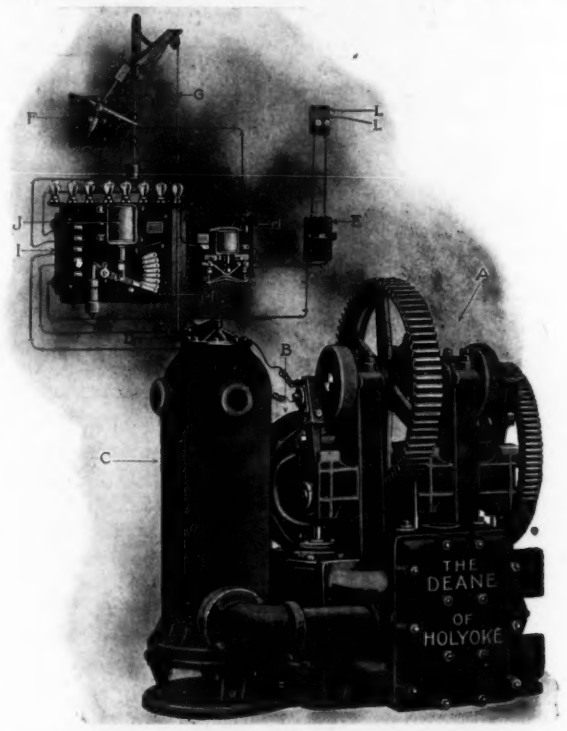
The recent improvements in vacuum pumps and allied apparatus, greatly simplify this latter operation and insure superior results with less skillful manipulation and especially with less engineering on the part of the man in charge. A special claim of the system of exhausting is that lamps of abnormal voltage are not produced in this operation, owing to its greater efficiency. Uniformity of voltage and current consumption is secured by an improved method of making the filaments, which average 200 hours longer life. The common method of carbonizing fibres, by binding them over carbon blocks or over brass blocks in the preliminary system, produces injurious strains in the molecular structure of the carbon, for the fibre would normally, if unrestrained, shrink to about two-thirds of its initial length, and as it cannot draw around the curves of the block after reaching the brown stage of baking, it tends to pull apart, and produces a carbon of high specific resistance in these parts as compared to those not strained, and also reduces the diameter slightly, although this is often difficult to detect. But in either case it is not entirely compensated for in the hydro-carbon treatment, as is generally supposed. In this treatment improvements have also been made. One of these is an automatic regulation of temperature, relative to the point at which the splitting up of the hydro-carbon molecule takes place, and which with a filtering mechanism, made possible in its operation by a higher vacuum than heretofore practicably obtainable in sufficient capacity for this work, maintains clean surfaces, so that each carbon atom "solders" smoothly to a clean surface. The presence of foreign gases, such as are the product of the hydro-carbon in the partial vacuum usually employed, produce a rough and spongy and easily worn off surface during the active life of the lamp.

Automatic Electric Pump and Receiver.

The illustration herewith shows a motor-driven, triplex, boiler-feed pump and receiver with automatic switches and motor-starter for automatically draining heating systems and factory apparatus, which depend upon a free circulation of steam for their efficiency. By doing this it serves a double purpose: First, it automatically relieves the system of the water of condensation constantly collecting therein, thus insuring a free and unobstructed circulation and incidentally prevents the snapping and hammering in the pipes, which is in many cases due to entrained water. Secondly, it delivers this water automatically and directly to the boilers without the intervention of tanks or other commonly-used devices. Not only does it relieve the system of a troublesome factor, but it introduces a supply of feed water into the boiler at a temperature impossible otherwise without the use of a special water heater. In modern hotels and apartment houses there is a great demand that machinery should operate with the least possible noise. One of the greatest annoyances is water hammer in the pipes reaching to every part of the building, but by the use of this outfit such noise is eliminated.

Electric pumps can be installed in locations to which it is impossible to carry any other motive power, and as this pump, by reason of its automatic control, runs only when occasion demands, no special attendance is necessary and the total cost of operation is for current actually used.

The following description will make the action of the apparatus plain: *A* is the pump, *B* the motor, *C* the receiver and *D* a lever, operated by a pail float within the receiver, which rises and falls as the water level changes. *E* is the main line switch, which operates by hand and is used to cut out the line when necessary. *F* is a switch operated by the float in the receiver through the chain and counterweight, *G*. *H* is the automatic switch which admits current to the motor-starter, *I*, when the switch, *F*, is thrown in by action of the float. *I* is the motor-starter which delivers current gradually to the motor and is operated through the solenoid, *J*. *K* is the fuse block and *L* the line wires. The switch, *E*, being closed, water in



PUMP AND DIAGRAM OF ELECTRICAL CONNECTIONS.

the receiver rises and throws in the float switch, *F*, thereby turning the current through the automatic switch, *H*, which in turn delivers it to the solenoid, *J*, thus gradually pulling up the lever, *I*, and gently starting the pump. As the water is pumped out and the float falls, the operation is reversed and the pump stops.

The engraving shows the standard type of double-acting pump and receiver with electrical connections and motor, as usually installed. The pump may be either single-acting or double-acting, as desired, the arrangement in either case being the same. The receiver is of the vertical form and consists of a cylindrical closed chamber or tank mounted on a bedplate secured to the base of the pump, so that the apparatus is compact and self-contained. An opening at the bottom of the receiver is provided with a pipe connection to the suction of the pump, and the water of condensation flows into the receiver through the inlets shown near the top. Three separate inlets are provided for convenience in connecting the returns.

The receiver float is of a patented type and is a simple pail open at the top and hung from a lever having a counterweight so placed as to overbalance the weight of the pail. The pail is kept filled with water, and when the receiver is empty the weight of this water causes the pail to hang in its lowest position. As soon as the water rises in the receiver above the pail, the weight of the float is immediately reduced to the mere weight of the pail, and the counterweight causes the pail to rise to its highest position and to throw the float switch, *F*, to start the pump. This style of float is very simple in construction, sensitive in operation, and has none of the objectionable features of the closed or ball float. The float is so guided as to hang in the center of the receiver without swinging and the receiver inlets are provided with hoods to prevent the entering water from interfering with the action of the float.

NEWS OF THE WEEK.

Financial Intelligence.

THE WEEK IN WALL STREET.—Stock speculation showed a waiting disposition on the approach of the national election, but the undertone continued bullish and prices became steady after a sharp rally from depressing tendencies early in the week. Renewed attention is given to industrials, and favorable views of the iron trade lookout create strong tendencies in the United States Steel and other like issues. United States Steel securities touched the highest prices of the year. The bond market is strong, with sustained prices for prime investments and increased activity in certain speculative specialties. None of the tractions or electrics figured conspicuously, but toward the end of the week some of the inactive industrials were features in the trading. The closing prices of Allis-Chalmers common and preferred were 13 and 55, respectively, the former being a net loss of ⅞ and the latter 5 points. General Electric is 3¼ points lower, closing at 173¼, after having touched 177, and Westinghouse is off 2 points, the last quotation being 171. Trading in Brooklyn Rapid Transit was on a large scale, 172,000 shares having been sold at prices ranging between 63⅞ and 68½, the closing price being 67—a net loss of ⅝ point. There was also an active trading in Metropolitan Street Railway, the closing quotation being 122⅝, which is a net loss of 1⅜ points. Western Union closed at 90⅝. In the curb market the volume of trading was reduced, Interborough Rapid Transit being weak at times, closing at 152, a net loss of 8⅞ points. Following are the closing quotations of November 7:

NEW YORK

	Nov. 1	Nov. 7		Nov. 1	Nov. 7
Allis-Chalmers Co.	13⅛	13	Electric Vehicle	14	14
Allis-Chalmers Co. pfd.	54	56	Electric Vehicle pfd.	19	19
American Tel. & Cable.	91	93	General Electric	173¾	175
American Tel. & Tel.	142	143	Hudson River Tel.	..	..
American Dist. Tel.	25	..	Interborough Rap. Tran.	150⅛	152⅛
Brooklyn Rapid Transit.	65⅛	68¾	Metropolitan St. Ry.	122⅜	123¼
Commercial Cable.	200	210	N. Y. & N. J Tel.	156	..
Electric Boat.	37	38	Marconi Tel.	..	..
Electric Boat pfd.	68	68	Western Union Tel.	90⅝	91
Electric Lead Reduction	⅛	¼	Westinghouse com	167½	170
			Westinghouse pfd	185	186

BOSTON

	Nov. 1	Nov. 7		Nov. 1	Nov. 7
American Tel. & Tel.	142¼	143	Western Tel. & Tel. pfd.	96	97
Cumberland Telephone.	118	118¼	Mexican Telephone	1¼	1¼
Edison Elec. Illum.	*250	246	New England Telephone	*133½	133
General Electric	..	174	Mass. Elec. Ry.	13	13⅜
Western Tel. & Tel.	19	18½	Mass. Elec Ry. pfd.	55	55

PHILADELPHIA.

	Nov. 1	Nov. 7		Nov. 1	Nov.
American Railways.	49¼	49⅜	Phila. Traction.	97¾	..
Elec. Storage Battery.	71	74⅛	Phila. Electric.	8¾	8⅞
Elec. Storage Battery pfd.	71	74⅛	Phila. Rapid Trans.	16	16
Elec. Co. of America.	9⅞	10			

CHICAGO

	Nov. 1	Nov. 7		Nov. 1	Nov. 7
Central Union Tel.	..	..	National Carbon pfd.	109	108½
Chicago Edison.	160	..	Metropolitan Elev. com.	22	22
Chicago City Ry.	180	181	Union Traction.	9	..
Chicago Tel. Co.	140	..	Union Traction pfd.	37	..
National Carbon.	37	38¼			

* Asked

UNITED GAS IMPROVEMENT.—Advices from Philadelphia state on the highest authority that negotiations looking to the acquisition by the United Gas Improvement Company of the American Light & Traction Company have been reopened and a successful outcome is confidently expected at an early date. The negotiations are said to be in such shape as to warrant the United Gas Improvement people in proposing for an allotment of stock with which to pay for the property. The American Light & Traction Company was formed under the laws of New Jersey in April, 1901, and has acquired the following properties: Western Gas Company, Milwaukee; St. Paul Gas Light Company, St. Paul; Grand Rapids Gas Light Company, Grand Rapids, Mich.; St. Joseph Gas Company, St. Joseph, Mo.; Madison Gas & Electric Company, Madison, Wis.; Binghamton Gas Works Company, Binghamton, N. Y.; Southern Light & Traction Company, San Antonio, Texas, and Consolidated Gas Company of New Jersey, Long Branch, N. J. The company has an authorized capital of $15,000,000 common and $25,000,000 6 per cent. preferred stock, of which there has been issued $4,680,400 of the former and $9,996,900 of the latter.

EFFECT OF NEW YORK SUBWAY.—It is early yet to judge of the effect of the New York Subway on surface or elevated travel. It is said that the street cars are for the present feeling it most. There is good authority for the statement that the Manhattan Elevated loss does not average more than $500 per day as compared with the earnings at this time a year ago. If continued for a year it would amount to only about $180,000 for the twelve months, or rather less than one-third of 1 per cent. on the $55,200,000 stock outstanding. As last year earnings were a little more than 8½ per cent. on the present volume of stock it would appear that there is no great danger of a drop below 7 per cent. Under the terms of the lease to the Interborough system Manhattan stock gets 6 per cent. per annum till 1906, with an extra 1 per cent. at the end of the year, if earned. From 1906 the rate will be 7 per cent.

NEW BOSTON EDISON STOCK.—The directors of the Edison Electric Illuminating Company, of Boston, have voted to recommend to stockholders the issue of 10,450 additional shares of stock. They also voted to call a special meeting of stockholders on November 18 to act on the same. The new stock will be issued to stockholders at $200 a share in accordance with the order of the gas commission July 10, 1903, authorizing the company to issue 20,000 shares at $200 a share for acquisition of suburban properties and extensions. In the event that the stockholders of the Edison Company, of Boston, authorize the issue of the new shares, as recommended by the directors, it is proposed to call for payments and allow interest thereon the same as was done a year ago. A payment of 25 per cent. will be called in January and the remaining 75 per cent. in May, the exact days not being determined.

OTIS ELEVATOR GOLD NOTES.—The Otis Elevator Company will, by the close of this year, it is stated, have anticipated all of its $400,000 4 per cent. gold notes maturing January 1, 1906. On January 1, 1907, $400,000 additional 4 per cent. gold notes mature, and with their payment the company will have no obligations except its $5,599,500 preferred and $6,350,300 common stock. The policy of the company is to anticipate the payment of its notes from surplus earnings as fast as expedient and, with the notes out of the way, an increase in dividend rate on the common stock may be expected. The company now pays 2 per cent. on its common stock, but for the calendar year 1903 it earned 9 per cent. thereupon. Instead of increasing its dividend the money has been used to retire notes in advance of their maturity; $200,000 was cancelled in August and $150,000 in June last.

ST. LOUIS RAILWAY MORTGAGE.—A mortgage deed of $10,000,000 on the property of the United Railways Company, St. Louis, Mo., was filed October 29. It covers all the company's property in the city and county, the privilege and franchises, the capital stock of the St. Louis Transit Company and 12,500 shares of the capital stock of the St. Louis Railroad Company, subject to a mortgage dated September 20, 1899, between the United Railways Company and the St. Louis Trust Company, and the mortgages antecedent thereto. The document also indicates that it was given to secure the United Railways Company on bonds issued by the St. Louis Transit Company known as "improvement twenty-five-year 5 per cent. gold bonds," dated October 1, 1904, and aggregating $10,000,000. The Mercantile Trust Company is named as trustee for the bondholders.

OMAHA TROLLEY BONDS.—Redmond & Co. are offering at 97½ and interest $2,500,000 first consolidated 5 per cent. bonds of the Omaha & Council Bluffs Street Railway Company, due 1928. The status of the issue is as follows:

Outstanding	$4,850,000
Reserved for prior lien	2,500,000
Ext., etc., at 85 per cent. of cost	2,650,000
Total	$10,000,000

The earnings for 1903 show a surplus after all charges of $242,402, or about 75 per cent. of charges.

DIVIDENDS.—The directors of the New York & Queens Electric Light & Power Company have declared a semi-annual dividend of 2½ per cent. on the preferred stock, payable December 1. The directors of the Washington Railway & Electric Company have declared a semi-annual dividend of 2½ per cent. on the preferred stock, payable December 1. Niles-Bement-Pond Company has declared a quarterly dividend of 1½ per cent. on the preferred stock, payable November 15. Pratt & Whitney Company has declared a quarterly dividend of 1½ per cent. on the preferred stock, payable November 15.

100 PER CENT. STOCK DIVIDEND.—The Pittsburg Reduction Company, manufacturer of aluminum, has declared a stock dividend of 100 per cent. The capital has been increased to $3,800,000.

Commercial Intelligence.

THE WEEK IN TRADE.—There is a steady improvement in business and preparations for future trade are stimulated by easy collections. All the leading branches of manufacture are in a better position. Activity is noted at iron furnaces, and the course of prices is still upward. Advances of 25 cents to $1 per ton are general at all markets, Southern quotations leading in strength. Finished materials show increased activity, with a firm undertone. Some large sales of rails to American and Mexican railways are reported. The other metals are all strong and higher. Copper is active at home and abroad, and exports break all records. The price passed 14 cents during the week, and is as high as it was a year ago. A feature of the week was the resumption of work by 10,000 Eastern cotton mill hands, but the Fall River tie-up continues, and the strike of a few mine employes has caused the idleness of about 40,000 miners in Indiana and Illinois, which has resulted in higher prices for bituminous coal. In the West and North retail trade distribution has been affected unfavorably by the warm weather, activity in fall farm work and ante-election interest, and for the same reasons jobbing sales are rather smaller in volume. The best trade reports come from the South, where cotton marketing is active. An immense winter wheat acreage is reported, possibly the record planting. In the East trade exhibits some irregularities, quiet prevailing in many lines. Traffic reports are satisfactory, railway earnings in October exceeding those of the same month last year by 7.6 per cent. The business failures for the week ending November 3, as reported by *Bradstreet's*, aggregated 200, against 180 the week previous and 216 the corresponding week last year. Money is easy and a number of centers report a return flow from the country districts.

WIRELESS FOR WESTINGHOUSE.—Pittsburg newspapers are responsible for the statement that communication by wireless telegraphy between the many plants of the Westinghouse interests is contemplated and a series of experiments looking to that end have been started. The two plants chosen for the experiments are those of the old Westinghouse Manufacturing Company at Schenectady, the personal property of George Westinghouse, and the Bryant Electric Company at Bridgeport, Conn. The system of wireless telegraphy which is being applied there is the American De Forest. Exhaustive tests are proposed, and if they produce as good results as are anticipated the extension of wireless telgraphy to connect all the Westinghouse works is but a matter of time. The purpose in this plan is to provide a means of instantaneous communication between the works and avoid the necessity of paying out thousands upon thousands of dollars a year in telegraph and telephone tolls. If the total amount of money paid by the Westinghouse concerns to the great systems of telegraph and telephone communication were known it would make plain the company's eagerness to escape these heavy charges. Few people realize that in the mention of the Westinghouse concerns there are included 17 separate companies stretching from St. Louis to New York, Bridgeport and Hamilton, Ont., in America, and six companies in foreign lands. While the immediate future does not promise the connection of the European works with the American concerns by this system, it is not beyond the hope of the wireless telegraph engineers that this will become in due time one of the ordinary means of transatlantic communication. The cable tolls saved in this manner would amount to a very large sum.

MINIATURE LAMP SITUATION.—It is reported in the New York electrical supply trade that a recent attempt to effect a combination among the manufacturers of miniature incandescent lamps has proved a failure, some of the prominent manufacturers of that specialty having refused to join. This branch of electrical industry has grown by leaps and bounds during the past few years, and so far as outward indications go, all parties at the production end appeared to be enjoying the benefits of the ever-increasing demands made upon them. It seems unfortunate therefore to many observers that such conditions could not have been allowed to remain, especially because, on account of the failure to effect a protective organization, some of the manufacturers are said to be unwisely pushing their goods in the market at "cut prices," one object being to divert custom from other manufacturers proceeding along the old and hitherto successful lines. In regard to this situation a well-known maker of miniature lamps said in a recent interview: "Our policy has always been that of fair dealing with our patrons, giving the best product possible at fair prices, ensuring a fair profit, and we do not wish to become party either to selling goods below cost of production or to forcing exorbitant prices from the trade with no improvement whatever in the goods." It would appear from all this that another ill-conceived attempt at a "combine" had gone the way of many predecessors.

SOME WATSON-FLAGG CONTRACTS.—The Watson-Flagg Engineering Company, 27 Thames Street, New York, has secured a contract for a 100-kw General Electric generator to be direct-connected to a 150-hp Harrisburg-Fleming side-crank engine for installation in the Lord & Taylor department store extension plant. The outfit will be utilized exclusively for lighting purposes. A 50-kw, 125-volt Crocker-Wheeler engine type generator arranged for direct connection to a Harrisburg-Fleming side-crank engine has been ordered for lighting use in the silk mills of the Milsch Manufacturing Company, of Paterson, N. J. A 50-kw Westinghouse, 125-volt, belted generator is to be installed in the Alfred Grew Piece Dye Works, Paterson, N. J. This outfit is intended for lighting use. The Watson-Flagg people have also taken lately some substantial contracts for wiring, notably for the Naval Academy at Annapolis. They have secured the contract for all the wiring work for the buildings outside those of the academic group, which is to be executed by the Lord Electric Company, of Boston, Mass. In Baltimore a big lot of work has been taken by the New York concern. Among the principal orders are those for the Maryland Casualty Company and the National Manufacturers' Bank.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY has sold to the Pennsylvania Railroad Company double motor equipments for 122 cars, as already noted, with Westinghouse multiple unit control for these cars and for 61 trailers. These equipments will be used by the Pennsylvania Company for its Long Island suburban traffic, and will be put into operation next spring. The motors will be of the latest type, with a rating of 200 hp each; they will embody the most modern ideas in both electrical and mechanical design, and will possess an extremely liberal overload capacity. The Westinghouse Co. has been very successful in the design of railway motors, and in the design of this equipment will undoubtedly maintain its reputation. The machinery for the Long Island power plant which is now being installed is also supplied by the Westinghouse Co., and will include three turbo-generators, each having a capacity of 5,500 kw, as a notable part of the plant. Westinghouse, Church, Kerr & Co., consulting engineers, are in charge of this installation.

MAGNETA CLOCK CONTRACTS.—The Magneta Company, of Zurich, Switzerland, and Bowling Green Building, of which concern Mr. W. Hommel is the local manager, reports recent receipts of several interesting contracts for Magneta clocks, without batteries and contact points, for installation in New York hotels and other big buildings. The Hotel Empire, Sixty-third Street and Columbus Avenue, is to be equipped with 140 clocks, while the new Fifth Avenue premises of the Gorham Manufacturing Company are to have 30 clocks. The Magneta Company contemplates the construction of an extensive plant on this side to be devoted exclusively to the manufacture of its clock specialties.

THE ELECTRICAL SUPPLY TRADE.—It is understood that after a long conference held in New York City at intervals during the past two weeks, an understanding has been reached between the recently formed National Electrical Supply Dealers' Association, the Electrical Contractors and a number of manufacturers, establishing the status of the "jobber" and contractor. The new arrangement, we are informed, will go into effect November 10, and its ultimate success will be watched with some interest, as such alliances in the past have for some reason or other not worked in complete harmony and have eventually been discontinued.

PLANT FOR JACKSON, ALA.—Mr. George F. Brockman, electrical engineer for the Jackson (Ala.) hydro-electric power plant, started the lights for the first time in Jackson, Ala., on November 4, but owing to low water only one-half the lights were turned on. He has just closed with the Liddell Machinery & Supply Company a contract calling for a 100-hp tubular boiler of the best make, 70 feet of 30 inch steel stack, a 100 hp Erie City engine, automatic slow speed, to be belted to a 45 kw Bullock generator and to a line shaft running a grist mill and ammonia pump for ice making.

THE INTERNATIONAL TELEPHONE MANUFACTURING COMPANY, of Chicago, which is rebuilding the public service telephone exchange for the municipality of Neepawa, Manitoba, has secured, in addition to its contract for central office equipment, an order for subscribers' telephones, replacing those formerly in use. When the exchange is completed it will be fully equipped with International apparatus, replacing equipment made in France.

EQUIPMENT FOR S. T. MYERS BUILDING.—The big office building under construction at 47-49 Maiden Lane by Mr. S. T. Myers is to have a 14-in. x 14-in., also a 13-in. x 12-in. Reeves engine arranged for direct connection to 75-kw and 60-kw generators, respectively. The switchboard has been ordered from the Walker Electric Company, while the Watson-Flagg Engineering Company, of 27 Thames Street, will do the wiring.

THE AMERICAN ELECTRIC TELEPHONE COMPANY, of Chicago, reports recent shipments of switchboard equipments to the following points: Brillion, Wis., 100-line switchboard; Ann Arbor, Mich., 50-line switchboard; Hoyt, Kan., 100-line switchboard; New Richmond, Wis., 220-line switchboard; Gower, Mo., 100-line switchboard; Pell City, Ala., 100-line switchboard.

FIRE PROTECTION AT THE ST. LOUIS EXPOSITION.—The buildings of the Columbian Exposition at Chicago were constructed of steel, yet that Exposition experienced a destructive and fatal fire, entirely consuming the large Cold Storage Building. The buildings of the St. Louis Exposition are constructed largely of wood, but such elaborate precautions have been taken in the provision of fire-fighting apparatus that a great fire is considered impossible. All buildings have been supplied with standpipes and hose connections, so that it will be unnecessary for firemen to bring hose to the scene of a blaze. There are two entirely independent water supply systems. One of these receives its supply directly from the city mains and the other, a high-pressure service, is supplied by fire pumps in the Steam, Fuel and Gas Building. Although the first is spoken of as a low-pressure service, the pressure ranges from 50 to 100 pounds over different parts of the grounds. The high-pressure system is constructed of wrought-iron pipe and has been tested at 300 pounds pressure. Its lines within the buildings are carried in trenches, from which branches are run up to the roof, where there are connections for 1½-in. hose. In addition there are sprinkler systems in some of the buildings, which have connections for outside fire engines, as well as regular connections with the interior piping, and there are frequent cross connections between the high and low-pressure mains. Hose lines and Babcock fire extinguishers are scattered throughout all buildings. Further, in the main buildings, there are 2 and 3-in. turret monitors, such as are used on fire boats. These are very powerful and will never be used except in extreme cases, as the jet from one of them would wreck all the exhibits in its path. The high-pressure mains are supplied by 14 Worthington Underwriter pumps, equipped with Fisher governors set to maintain a pressure of 150 pounds per square inch. They are located on the north side of the Steam, Fuel and Gas Building and discharge into a 20-in. main, which branches into two 16-in. lines. The water supply for these pumps is taken from a 12-in. city main along University Boulevard, or if necessary from Arrow Head Lake, which is one of the features of the Philippine exhibit, and has a capacity of 900,000,000 gallons. The pumps are each of 1000 gallons per minute capacity, capable of supplying four fire streams, making it possible to have 56 streams playing at one time. The pumps are of the duplex, double-acting type and are supplied with air and vacuum chambers of large capacity. The fittings are of composition metal, and the pistons and valve rods are of bronze.

BALL ENGINE SHIPMENTS.—Among recent shipments of engines by the Ball Engine Company, Erie Pa., are the following: Lorain Steel Company, Lorain, Ohio, one 160-hp, direct-connected. Richmond, Fredericksburg & Potomac Railroad Company, one 300-hp, direct-connected. The Flannery Bolt Company, Bridgeville, Pa., one 100-hp. Michigan Sanitarium and Benevolent Association, Battle Creek, Mich., one 200-hp, direct-connected. New York & Pennsylvania Company, Johnsonburg, Pa., three 135-hp engines; one 175-hp. Pittsburg Brewing Company, Pittsburg, one 135-hp. Steelback Hotel Company, Louisville, Ky., three 225-hp, tandem compound, direct-connected. Hotel Nelson, Rockford, Ill., one 175-hp. United Gas & Electric Company, Albany, Ind., one 80-hp, vertical engine, direct-connected. Harry W. Oliver Power Plant, Pittsburg, Pa., one 700-hp, vertical cross-compound Corliss, direct-connected to alternator. Clarksburg Electric Company, Clarksburg, W. Va., one 600-hp Corliss, direct-connected to alternator. Eastman Kodak Company, Rochester, N. Y., two 400-hp, vertical cross-compound, direct-connected. J. M. Deerholm Bros. & Co., Limited, Pittsburg, Pa., one 135-hp, direct-connected. State Penitentiary, Richmond, Va., two 80-hp, direct-connected. Hotel Traymore, Atlantic City, N. J., one 75-hp, direct-connected. Detroit Trust Company, Detroit, Mich., one 400-hp. C. A. Burton Machinery Company, Kansas City, Mo., one 160-hp, direct-connected. Dravo, Doyle & Co., Cleveland, Ohio, two 60-hp, direct-connected. City Lighting Plant, Wilton Junction, Ia., one 125-hp. The Ball Engine Company has also received an order for a 1,000-hp horizontal cross-compound Corliss engine for the Altoona shops of the Pennsylvania Railroad.

ADVANCE IN COPPER.—Mr. J. P. Stanton, the expert, says in regard to the copper market: "The demand for copper is extraordinary. There has been no attempt made to corner copper for the simple reason that there is no copper to corner. Stocks on hand amount to practically nothing. All the copper that is now being taken out of the ground is in process of being put into marketable shape which will probably be needed to fill existing contracts. That the market position of the metal is firm is shown by the pronounced demand for futures. Not long ago contracts called for delivery 60 and 90 days ahead. At present buyers are making contracts that call for delivery in January, February and March of next year. Copper production in 1904 will show an increase over the preceding year, but this increase will be so small that it will not be noticed. I would like to see the price of copper maintained around 14 cents a pound, but there is no telling where prices will go in the face of an extraordinary demand with no stocks on hand to supply consumers' wants. Russia, France, Germany and the Far East are large buyers of copper, but Great Britain is doing very little in this line. However, there is every reason to believe that Great Britain will be in the market for large supplies in the near future. I attribute the increase in the consumption of copper more to electrical development than anything else."

SOME BUFFALO FORGE ORDERS.—The Buffalo Forge Company, New York offices, Taylor Building, reports recent receipt of a batch of orders for engines to be installed in various electrical plants and for motors to be used for pumping machinery. The list includes an order for two 40-hp horizontal center crank engines arranged for direct connection to 35-kw, 230-volt Sprague generators for lighting and elevator power at the Hotel Earle, 103 Waverly Place, New York. Four 40-hp Buffalo vertical engines have also been called for. These are to be direct connected to 25-kw, 115-volt Crocker-Wheeler generators and will be used for lighting the mines, etc., of the Calumet & Arizona Mining Company. The Public Service Corporation of New Jersey has ordered some Buffalo centrifugal pumping machinery which will be direct connected to a vertical shaft motor to be built by the Northern Electric Manufacturing Company, of Madison, Wis.

TURBINE EQUIPMENT FOR NEW YORK MANUFACTURING PLANT.—The Turbine Engineering Company, Whitehall Court Building, New York, of which Mr. L. G. Read is general manager, has just secured the contract for the complete power equipment to be installed in the new mirror manufacturing plant of Mr. Jacques Kohn, to be built at Thirty-seventh Street and Tenth Avenue, New York. There will be two 150-hp De Laval turbine dynamo sets and a De Laval centrifugal pumping outfit. The contract also calls for a complete Wheeler condensing equipment. The boilers are to be of Babcock & Wilcox build in two units of 200 hp capacity each. The motors—about a dozen—have not yet been contracted for. Schickel & Dittmars, Fifth Avenue and Eighteenth Street, are placing the contracts.

ORDERS FOR LIDGERWOOD ELECTRIC HOISTS.—The Lidgerwood Manufacturing Company, 96 Liberty Street, has secured a contract for four electric hoisting equipments which are to be used in connection with the construction of the Quebec bridge to be built over the St. Lawrence River. The Lidgerwood people have also obtained an order to finish the electric shaft hoists and cages which are to form the entire elevating outfits for the shafts of the North River section (O'Rourke Construction Company's contract) of the Pennsylvania Railroad tunnel, at Weehawken, N. J., and at the foot of West Thirty-fourth Street, New York.

POWER HOUSE FOR BALTIMORE.—Mr. S. Davies Warfield, chairman of the executive committee of the United Electric Light & Power Company, announces that plans have been consummated for the erection of one of the largest electric light and power generating stations in the United States. The company has purchased twenty-two acres of land immediately adjoining the city and having a water front of over 1000 ft. The new generating station which will be located upon this land will provide for all needs of the city for electric light and power for many years to come.

NEW SKYSCRAPERS FOR THE SOUTH.—The Candler Investment Company, of Atlanta, Ga., which is controlled by the Coca-Cola interests, contemplates the erection of a number of large office buildings in the South. Under construction at present is the 17-story Candler Building at Atlanta, which will have a good-sized electric lighting plant.

PELTON EQUIPMENT FOR NOVA SCOTIA.—The Pelton Water Wheel Company, 143 Liberty Street, New York, has secured an order for equipment to be installed in a new water power plant to be built for the purpose of generating energy to light Bridgetown, Nova Scotia. The initial equipment will be of 150 hp capacity. The Pelton order also calls for 3,000 feet of steel riveted pipe.

ROSEMONT TRANSMITTER.—A petition in bankruptcy has been filed against the Rosemont Electric Transmitter Company, of No. 207 Greene Street, New York City. The liabilities are $13,000 and assets, consisting of accounts, $3,500, some stock unfinished, of little value, and patents. The bankruptcy, it is stated, was precipitated by dissensions in the board of directors.

MOTORS FOR DIXON CRUCIBLE PLANT.—Several motors and other electrical machinery are to be installed in the new rubber plant in Jersey City, owned by the Joseph Dixon Crucible Company. The Crocker-Wheeler Company, through its New York offices, Taylor Building, Mr. F. B. DeGress, manager, has taken an order for six motors aggregating 200 hp.

EQUIPMENT FOR NATIONAL WIRE PLANT.—The National Wire Corporation ordered recently a 400-kw Crocker-Wheeler engine type generator to be direct-connected to a C. & G. Cooper Corliss engine for its New Haven (Conn.) plant, and this week has contracted for three 35-hp and two 5-hp motors of Crocker-Wheeler build.

General News.

THE TELEPHONE.

PHOENIX, ARIZ.—The Badger Telephone & Telegraph Company has been incorporated with a capital stock of $1,000,000. The incorporators are Frank M. Fish, John K. Fish and G. W. Whitehead.

LOS ANGELES, CAL.—The Home Telephone & Telegraph Company, of Santa Monica and Ocean Park, has been incorporated with a capital stock of $250,000.

CARROLLTON, GA.—The long-distance telephone company has bought out the local company here and the two systems have been merged.

CHAMBLEE, GA.—A telephone line is being built from Morgan Falls electric works to Chamblee, Ga., connecting also with the line to Dunwoody, Ga.

CHICAGO, ILL.—The monthly statement of the Chicago Telephone Company for October shows that 1479 new telephones were installed. The total number of telephones in both the city and country districts is now 115,293.

FLORA, IND.—The Flora Co-operative Association will purchase the John Q. Miller system of this place.

INDIANAPOLIS, IND.—The Mt. Zion Telephone Company has increased its capital stock from $6000 to $25,000.

LOGANSPORT, IND.—Within the next few weeks the Home Company will have a through toll line between this city and South Bend, a distance of 64 miles.

SIBLEY, IA.—At a special meeting of the Sheldon Commercial Club it was decided to ask the town for a franchise for an independent telephone system.

BURLINGTON, IA.—The Burlington Rural Route Telephone Company has been granted all rights and privileges to establish a telephone service in this town.

WATERLOO, IA.—Murphy & Ralston, architects, of Waterloo, have plans for a central exchange building for the Iowa Telephone Company to cost $10,000.

BLAKEVILLE, IA.—The Blakeville Farmers' Mutual Telephone Company has been incorporated with a capital stock of $5000. C. W. Smith is president and Wm. Rodgers, secretary.

DES MOINES, IA.—The Mutual Telephone Company is planning to extend its line along the Prairie City road east of the city about ten miles from the city limits. Work on the new line will commence within a short time and will accommodate about 250 farmers in that vicinity.

WEST UNION, IA.—The Rogers Telephone Company is being organized. Chas. A. Towne, Jas. S. Clarkson, Coker F. Clarkson, Theodore C. E. and Fred C. Blanchard and W. W. Blanchard are interested in the organization. The company will amalgamate the independent telephone companies in this and surrounding counties.

NEWTON, MICH.—The Newton & Leroy Telephone Company has been organized to build farmers' lines in the two-named townships. The stockholders are E. C. Corey, J. A. Hurd and others.

ROCKLAND, MICH.—At the annual meeting of the stockholders of the Ontonagon Telephone Company the officers were re-elected as follows: President, James Mercer; vice-president, B. F. Chynoweth; secretary, L. Stannard; treasurer and general manager, George W. Stannard.

MUSKEGON, MICH.—Muskegon is now connected with Hart by two telephone lines of the independent companies. A second copper wire line has just been completed. It was begun last spring by the Citizens' Telephone Company, of this city, which carried it as far as Whitehall. The remainder of the distance has now been finished by the Lake Shore Telephone Company of Oceana County.

ST. PAUL, MINN.—The Twin City Telephone Company has applied for a franchise to construct an underground system.

BUTTE, MONT.—Harry W. Turner and Max Hebgen have purchased from Eric V. Haser, of St. Paul, the Havre Light Telephone Exchange and coal mines, for which they paid $40,000.

TRENTON, N. J.—The American Telephone & Telegraph Company, of New Jersey, and the Telephone & Telegraph Company of New Jersey have filed agreement of merger at Trenton. The capital stock is $250,000, and the directors of the company are Edward J. Hall, Melville Egleson, George H. Minster, Harry H. Brigham and Samuel H. Mocal.

ALBUQUERQUE, N. M.—The Board of County Commissioners of Lincoln County has granted a franchise to O. P. Pierson for a right of way to construct telephone lines in Lincoln County. A line between Capitan and Lincoln is to be in operation within 90 days.

ALBANY, N. Y.—The Lester Telephone Company, of Windsor, Broome County, has been incorporated with a capital stock of $2000. The directors are W. Weightman, H. A. Williams and A. S. Judd, of Windsor.

BUFFALO, N. Y.—At the annual meeting of the Frontier Telephone Company the following officers were elected: President, Henry H. Persons; first vice-president, E. C. Lufkin; second vice-president, S. E. Wayland, of Scranton; Fred L. Mesmer, treasurer, and John Jolly, secretary.

COLUMBUS, OHIO.—The Barlow & Watertown Telephone Company has been formed, capital $10,000. Directors: H. and L. A. Fischer and others.

CLEVELAND, OHIO.—The police department has received $10,000 worth of new telephone and telegraph cable that is to be used in enlarging the department's system of underground connections.

BOWLING GREEN, OHIO.—The Haskins Bell Telephone Company, which was organized by Haskins men four years ago, has acquired the interests of the Haskins Mutual Company and will hereafter control all the telephone business in Haskins.

COLUMBUS, OHIO.—Ohio capital has secured control of the Home Telephone Company of Charleston, W. Va., and at the stockholders' meeting in that city Frank L. Beam, general manager of the Columbus Citizens' Telephone Company, and Cyrus Huling, president of the Columbus Savings & Trust Company, were elected directors. This action is said to foreshadow a complete reorganization of the company and a material extension of the system. This latter will comprise extensions both to the north and west for an ultimate connection with the Columbus and Dayton systems, controlled by the same interests, and to the south. It is understood that the deal represents an investment of approximately $200,000, and is the entering wedge of a movement to control the telephone business of central West Virginia.

WHITE HALL, PA.—The Bell Telephone Company will build a line between Hanover and Littletown.

UNIONTOWN, PA.—The Bruceton & Fairchance Telephone Company has been incorporated in West Virginia with a capital stock of $100,000, and purposes to build a line from Bruceton, W. Va., to connect with the lines of the Tri-State Company at Fairchance, Pa. The officers are J. H. Walls, Brockville, W. Va., president, and George B. Irvin, Fairchance, vice-president.

DILLON, S. C.—Subscriptions are being raised to build an independent telegraph line from Dillon, S. C., to Gibson, N. C., to connect with the Postal Company, because of the alleged refusal of the Western Union Telegraph Company to establish an independent office in Dillon.

ALVIN, TEX.—The Alvin & Angelton Telephone Company is arranging to extend its lines.

MADISON, WIS.—The Pierce County Telephone Company has filed an amendment increasing the capital stock of the company from $10,000 to $30,000.

DE PERE, WIS.—The Wisconsin Telephone Company will extend its line from the De Pere office to the town of Rockland, a distance of about 6 miles.

JANESVILLE, WIS.—About 30 independent telephone companies of southern Wisconsin and northern Illinois were represented at a recent meeting in this city for the purpose of consulting with regard to the overtures which the Bell Telephone Company has recently been making to the individual independent concerns to connect with its toll lines. The opinion was unanimous against accepting the Bell offers.

WINDSOR, ONT.—The Ontario Independent Telephone Company has effected permanent organization and elected the following officers: President, John H. Connelly, Windsor; vice-president, James A. McRae; treasurer, Fred J. Lawrence; secretary, A. D. Prosser; general manager, C. W. Taylor; assistant general manager, P. T. Chesley.

ELECTRIC LIGHT AND POWER.

FLORALIA, ALA.—The Council has granted W. R. McDuffie a franchise for an electric light and power plant.

DARDANELLE, ARK.—The new owners of the Dardanelle Cotton Mills will apply for an electric light franchise.

UKIAH, CAL.—The Ukiah Redwood Lumber Company has been incorporated, with a capital of $50,000, to establish an electric light plant; C. A. McComber and S. C. Golden are the incorporators.

SAN LEANDRO, CAL.—The Mt. Diablo Light & Power Company has been incorporated, capital $50,000. Directors: J. W. Burge, of Haywards; C. A. Jeffrey, Oakland, and G. J. Clark, of San Leandro.

OROVILLE, CAL.—The Tehama County Water Company has been incorporated by B. A. and S. M. Steifer, of Nimshew, Cal., with a capital of $1,500,000. The company is organized for the purpose of manufacturing electricity.

OAKLAND, CAL.—Mt. Diablo Light & Power Company has been incorporated with a capital stock of $50,000. The directors are J. W. Burge, of Haywards; C. A. Jeffrey, L. B. Smith and Wilton Shuhaw of Oakland, and G. W. Clark, of San Leandro.

RIVERSIDE, CAL.—The chairman of the City Trustees has been instructed to sign a contract with the Westinghouse Electric & Mfg. Company for the purchase of electrical machinery as follows: Three 200-kw, air blast transformers; one blower for transformers; one polyphase potential regulator and three 10,000-volt lightning arresters. The price named was $4150.

THOMASTON, CONN.—At the annual meeting of the Thomaston Electric Light Company, the old board of directors was chosen. The officers of the company are J. S. Eastwood, president; F. J. Roberts, secretary and treasurer.

MYSTIC, CONN.—The managers of the Westerly Electric Railway & Lighting Company, which during the summer absorbed the Mystic Electric Light & Power Company, have decided to shut down the lighting plant here and furnish the consumers in Stonington, Mystic, West Mystic and Noank with power and light direct from the power house in Pawcatuck. The power house here will be held as an emergency plant.

CANAAN, CONN.—The stock of the Norfolk Electric Light & Power Company has been transferred to the following new stockholders: Francis R. Cooley, of Hartford; William R. C. Corson, of Hartford; Arthur D. Newton, of Hartford; Walter S. Morton, of New York; J. H. Roraback, of Canaan. The officers are as follows: President, J. H. Roraback; treasurer, A. D. Newton; secretary, W. S. Morton. The Berkshire Power Company, which proposes to erect a dam and electric power house on the Housatonic River near the toll bridge in Canaan will commence work in a few days and when the plant is completed the present Norfolk Electric Light & Power Company will be merged into the Berkshire Power Company, which is virtually the same body of people.

WINTER PARK, FLA.—A charter has been granted to the Winter Park Electric & Fuel Company, of Winter Park, with a capital of $25,000. J. M. Cheney, H. W. Greetham and H. H. Yowell are the incorporators.

DUBLIN, GA.—The citizens have voted to issue bonds for improving the electric light plant.

TENNVILLE, GA.—It was voted Oct. 25 to issue $8000 bonds to purchase the electric light plant and improve the water works. S. H. B. Massey is clerk.

HERRIN, ILL.—The capital stock of the Herrin Light & Power Company has been increased from $20,000 to $50,000.

LA GRANGE, ILL.—The La Grange Service Company, of Chicago, has been incorporated with a capital stock of $100,000, for the purpose of buying the electric light and water works plant of this village. The incorporators are B. McKeever, G. C. Madison and others.

SPRINGFIELD, ILL.—A temporary injunction has been granted by Judge Creighton, of the County Circuit Court, restraining the consolidation of the Springfield Electric Light & Power Company with the Springfield Heat, Light & Power Company. The opinion of the court as expressed orally was that a combination of utilities of the city would be against public policy and a violation of the anti-trust laws.

CENTRAL CITY, IA.—The question of establishing an electric light plant will be voted on.

WICHITA, KAN.—A franchise was granted to the Citizens' Electric Light, Heat & Power Company to install a new electric lighting and heating plant.

COLUMBIA, KY.—A new electric lighting plant is to be installed here.

COVINGTON, KY.—Thos. J. Creaghead, of Covington, will prepare preliminary plans for the municipal electric light plant.

LEOMINSTER, MASS.—The Leominster Electric Light & Power Company will improve its plant, putting in new machionery, poles and wiring.

HOLYOKE, MASS.—The Board of Aldermen has passed a loan order for $30,000 to be used for reconstructing and enlarging the electric-light station.

MELROSE, MASS.—The committee on street lighting of the city government has been authorized to confer with the Malden Electric Light Company to ascertain the cost of having the streets lighted all night and every night in the year.

WINONA, MINN.—Bonds have been voted here for enlarging the electric light plant. H. M. Lamberton has secured a 25-year franchise from the city for the establishment of an electric lighting plant.

AMORY, MISS.—Mr. A. A. Carlisle, of the Wesco Supply Company, St. Louis, Mo., has sold a complete electrical installation for the electric light plant in Amory, Miss., consisting of 150-kw. Triumph generator, Hardie-Tymes Corliss engine and boilers, Adams-Bagnall arc lamps, Peerless incandescent lamps, and the necessary material for installing the plant.

TROY, MO.—At a special election held October 26 the proposition to issue $10,000 bonds for the purpose of establishing electric lights in Troy was carried.

HARVARD, NEB.—Jerry Delaney, of Harvard, has secured a franchise to construct and operate an electric light plant.

DARTMOUTH COLLEGE, N. H.—The trustees have voted to install electric lighting equipment at the heating plant, which was made large enough for the proposed new system.

KEARNY, N. J.—The Council has appropriated the cost of building a municipal lighting plant.

NEW YORK, N. Y.—Through the recording of a mortgage given by the New York & Westchester Lighting Company to the Central Trust Company for $10,000,000, the Westchester County Lighting Company and the New York & Westchester Lighting Company have effected a merger of their interests.

SALISBURY, N. C.—The plant of the Whitney Reduction Company, which is utilizing the narrows of the Yadkin River near Salisbury, N. C., is now on a firm financial basis and the work is steadily progressing. The canal from which the power will be derived will be over four miles long. Twenty-six thousand horse-power is to be developed. The river has a fall of 300 feet in ten miles.

ARLINGTON, S. D.—The Central Dakota Milling Company has petitioned for a franchise for an electric light plant.

GANADO, TEX.—Steps have been taken by a number of the leading rice growers of the section around Ganado, Tex., to combine their irrigation interests and establish a large central electric power plant for the purpose of furnishing power for operating their irrigation plants.

BRADFORD, VT.—Charles A. Prouty, of Newport, has purchased controlling interest in the Bradford Electric Light Company.

LURAY, VA.—A charter has been granted to the Luray Electric Company, with a capital of $15,000. E. C. Harnsberger is president; R. T. Morrison, of Luray, secretary.

HARRINGTON, WASH.—F. E. Christensen, of Ritzville, Wash., has petitioned for a franchise for an electric light plant.

SEATTLE, WASH.—The Snoqualmie Falls & White River Power Company, of Seattle and Tacoma, by amended articles of incorporation, has changed its name to the Seattle-Tacoma Power Company, and has increased its capitalization to $3,500,000, of which $1,250,000 is 6% preferred stock, non-cumulative, and $2,250,000 is common stock.

APPLETON, WIS.—The Negaunee Gas Company and the Negaunee & Ishpeming Gas & Electric Company have been consolidated. Mr. Thomas Rockwell, formerly at the head of the Fox River Gas & Electric Company, will be president of the new company, and E. H. Finch will be secretary.

QUERETARO, MEX.—The water of the Tequisquipam Springs, in the State of Queretaro, is to be utilized for power purposes. The water will be conveyed through a canal to the agricultural regions of San Juan del Rio, after it has first been used to generate electric power. The power generated at Tequisquipam will be conveyed to the city of Queretaro by transmission lines and will be used to light that city and to operate factories and other industries. Engineer H. Alcocer is in charge of the construction of the works.

THE ELECTRIC RAILWAY.

FORT SMITH, ARK.—The Fort Smith Light & Traction Company, of Arkansas, has increased its capital stock from $200,000 to $250,000 preferred and $750,000 common.

QUITMAN, GA.—An electric railway will probably be built here. It will be about 1½ miles long, and owned and operated by the town, and will be used in hauling coal and cotton as well as passengers.

ALTON, ILL.—The syndicate which is building the Alton-St. Louis Interurban Electric Railway is planning for an increase in the available power supply at the Alton electric power plant, which will be the principal plant for the line.

MONTPELIER, IND.—Montpelier and Montpelier Township have voted the Huntington, Columbia City & Northern Electric Railway a subsidy of $25,000.

EVANSVILLE, IND.—The Common Council has passed the franchise of the Evansville & Eastern Traction Company. M. L. Sontag is general manager of the new company.

CRAWFORDSVILLE, IND.—It is rumored that the Indianapolis & Northwestern Traction Company is to buy the grade of the Consolidated Traction Company from this city to Indianapolis. The grade is completed and ready for the ties and iron and the bridges are nearly all completed.

PORTLAND, IND.—The Geneva Traction Company has procured all of the right of way for its line between Marion and Celina, Ohio, and proposes to push the work of grading until winter stops the work. The line has been financed by Eastern capitalists, represented by D. M. Shively, of South Bend.

NEW CASTLE, IND.—The Commissioners have granted C. N. Maikels a franchise for an electric railway through Henry County to the corporation line in this city. The route follows the right of way of the Panhandle Railroad. The Commissioners have also taken steps to revoke the franchise granted to the Union Traction Company for a line from Anderson to New Castle, on the ground of nothing having been done except to lay track on three places or on disputed territory.

DES MOINES, IA.—The Des Moines City Railway Company has definitely decided on the extension of the Scott Street line from its present terminus to Youngstown, Carbondale and the brick plants along the Wabash Railroad. The extension will be about three miles long and pass through a portion of the city of Des Moines which at present is without street railway facilities. The main object of the construction of this line is to give a railroad outlet to the coal and brick industries east of the city.

DES MOINES, IA.—Word has been received from F. S. Mordaunt, promoter of the St. Joseph, Albany & Des Moines Electric Railway, that arrangements for terminals in St. Joseph have been satisfactorily concluded with the Union Terminal Company, of that city, also that a new route will have to be surveyed out of St. Joseph for a distance of six miles, in order to make connections with the lines of that company. Mr. Mordaunt has been in several Iowa towns during the past months negotiating for right of way, the voting of taxes, etc. He now states that construction work will be commenced early next spring.

BOSTON, MASS.—The Boston & Worcester Street Railroad Company has petitioned the Railroad Commissioners for permission to issue $160,000 additional capital stock and $160,000 4½ per cent. twenty-year bonds. The proceeds will be used for double tracking part of the road and other improvements.

WATERTOWN, N. Y.—The Chamber of Commerce is trying to establish a belt line system in this city. The movement was started by Henry Lefebre, manager of the Black River Traction Company.

ITHACA, N. Y.—The Common Council of Ithaca and its Highway Commissioners have granted the petition of the Cayuga Heights Railroad Company to build its proposed road from Cornell Heights through Cayuga Heights and connecting with the Ithaca Street Railway system at Renwick.

CLEVELAND, OHIO.—The Cleveland Electric Railway Company has obtained a franchise from the Village Council of Collinwood, which will permit the company to extend its line on St. Clair Street to connect with the Euclid Beach line of the company.

GALION, OHIO.—The Galion Southern Railway Company has been incorporated, with $16,000 capital stock, by M. K. Arnold, A. A. Crawford, Oscar Wise, Walter L. Bell, J. C. Bowen. The company expects to build a line from Galion to Fredericktown and Mount Vernon.

FINDLAY, OHIO.—The Toledo, Bowling Green & Southern Traction Company is placing contracts for the equipment of its new power house in this city. A contract has just been closed with McIntosh, Seymour & Company, of Auburn, N. Y., for two 1500-hp engines for the new plant.

CLEVELAND, OHIO.—Mayor Finch, of Toledo, together with a number of officials of the Toledo, Port Clinton & Lakeside Railway, made a special trip from Cleveland to Toledo a few days ago. The event was the formal opening of the new line, which is now in operation from Toledo to Port Clinton.

MARION, OHIO.—The Findlay & Marion Railway & Light Company has elected these directors: Thomas S. Thorn, W. H. Davidson and Edwin M. Moser, of Toledo; E. E. Kerr, of Cochranton, and Samuel W. Waltermire, of Forest. The company expects to build from Marion to Findlay by way of Upper Sandusky and Carey. The road will complete a through line from Columbus to Toledo.

LIMA, OHIO.—The Indiana capitalists who built the Fort Wayne, Van Wert & Lima Traction Company are said to be back of a project for a line from Lima to Toledo by way of Ottawa and Deshler. The Western Ohio Railway is figuring on extending its line to Findlay, which would give it connection with Toledo, but if the other road is built this would furnish a shorter route to Toledo.

GUTHRIE, OKLA.—A territorial charter has been issued to the Kansas & Oklahoma Interurban Railway Company, with headquarters at Kansas City and with $1,000,000 capital stock. The proposed system includes city systems at Arkansas City and Winfield, with connecting lines to Gueda Springs, Kan., and Chilocco, Okla. The incorporators are L. H. Northrup, D. N. Sanders, Charles Brown, Thomas Baird and A. J. Hunt, of Arkansas City; W. H. Somermier and W. C. Robinson, of Winfield, with Charles Johnson, of Newkirk, as territorial agent.

PARKESBURG, PA.—The Town Council has passed an ordinance granting a franchise to the Parkesburg & Oxford Electric Railway Company, whose line is to be 14 miles long and is to be completed in a year.

BLOOMSBURG, PA.—The Columbia & Montour Electric Railway Company has decided to make a number of improvements to its system. Within the next six months the company will build a power plant at or near Berwick. In this plant will be installed a 200-kw generator and an engine of 300-hp or 400-hp. The company will also place a rotary converter of 150-kw at the sub-station at Willow Grove, in addition to the equipment now in that plant.

PROVIDENCE, R. I.—The awarding by the New York, New Haven & Hartford Railroad Company of the contract for the increase of power in the work of electrifying the Warren, Bristol and Fall River branch will furnish a means of doing away with the locomotives on any part of the branch hereafter. The additional power equipment will be supplied by Westinghouse, Church, Kerr & Company. The power house, which is located at Warren, Conn., will be greatly enlarged, four Babcock & Wilcox boilers of 400-hp each will be installed, and two Westinghouse-Parsons steam turbines coupled directly to two 750-kw Westinghouse alternating-current generators will develop the electric current at a pressure of 13,200 volts. The steam turbines will operate at a speed of 1500 r.p.m.

MOOREFIELD, W. VA.—It is proposed to build a standard gauge electric freight and passenger railway from Moorefield to Green Spring, the preliminary survey having already been made. At Green Spring the line will connect with both the Baltimore & Ohio and the Wabash systems. J. William Gilkessen, cashier of the South Branch Valley Bank, Mooresfield, is interested.

NEW INDUSTRIAL COMPANIES.

THE CHICAGO STAGE LIGHTING COMPANY has been incorporated with $2500 capital, to manufacture electrical apparatus. Directors: J. J. Fanning, G. E. and W. J. Stevenson, and others.

THE STANDARD STORAGE BATTERY COMPANY, of Jersey City, N. J., has been incorporated with a capital stock of $500,000. The incorporators are Lewis B. Dailey, H. C. Coughland and B. S. Mantz.

THE SAFETY CONTROL ELECTRIC COMPANY, of Newburg, N. Y., has been incorporated with a capital stock of $50,000. The directors of the company are J. L. Robertson, C. A. Gaiser and W. P. Godfrey, of New York.

THE ELECTRO-CHEMICAL COMPANY OF AMERICA, of New York, has been incorporated at Dover, Del., with a capital stock of $400,000. The company is authorized to erect manufactories for electric and scientific products.

THE INTERNATIONAL TOOL COMPANY, Chicago, Ill., has been incorporated by Wm. F. Behrens, Adolph Peck and Frank J. R. Mitchell. The new company, which has a capital of $20,000, will manufacture tools and machinery.

THE INDEPENDENT TELEPHONE SECURITIES COMPANY, of Utica, N. Y., has been incorporated with a capital stock of $800,000. The directors of the company are T. H. Ferris and C. H. Poole, of Utica, and C. G. R. Fuller, of Rochester.

THE GAS BILL REDUCING COMPANY, Chicago, Ill., has been incorporated with a capital of $14,000. The new company, of which William O. McCullough, Frank P. Gillett and Charles McLean are the incorporators, will manufacture gas and electrical apparatus.

THE WATSONVILLE ELECTRICAL COMPANY, of Watsonville, Cal., has been incorporated with a capital stock of $25,000, of which $6000 is paid up. The directors of the company are W. A. White, J. A. Schanbacher, A. White, J. A. Linscott and W. D. Gulick.

THE REED ELECTRICAL CORDAGE COMPANY is to start in business at New Haven, Conn., with a capital of $50,000, of which $20,000 has been paid in. The concern will use a machine for cordage making that has just been invented by T. S. Reed, one of the heads of the firm.

AMERICAN NON-METALLIC STORAGE BATTERY COMPANY, of New York, to make and install storage batteries, to sell the product so made and to make and sell apparatus and instruments pertaining thereto; capital stock, $25,000. The directors are A. Arthur King, Henry Hellwig, Charles Busch, Geo. J. Wohltmann and Geo. J. M. Ketner, all of New York City.

THE STANISLAUS POWER COMPANY, which has been incorporated at San Francisco by Sidney Sprout, Max L. Rosenfield and E. E. Peabody, of San Francisco, and J. A. Thomas, of Los Angeles, has a capitalization of $5,000,000; subscribed, $500. It is proposed to install a water-power electric transmission plant in Stanislaus County, that is to supply light and power in the central counties of California. San Francisco is named at the principal place of business. The plant is to be installed as soon as possible on the Stanislaus River at a point about 15 miles south of the Electra station of the Standard Electric transmission system, now controlled by the California Gas & Electric Corporation. The water wheels, to which the polyphase generators will be direct connected, will be operated under a head of 2000 feet of water. A representative of the new corporation says that contracts have been closed for the entire outturn of the projected plant. There are rich mining districts within transmission distance of the power site and the lines of the California Gas & Electric Corporation are so contiguous that the surplus power could be sold to that concern if desired.

OBITUARY.

MR. H. E. RAYMOND.—Mr. Henry E. Raymond, electrical engineer and assistant manager of the construction department of the General Electric Company at Schenectady, was found dead in his room in the Hotel Manhattan, New York City, on November 2, having hanged himself with a part of the webbing of the Venetian blinds directly before the window, which opened on Forty-third Street. Mr. Raymond was thirty-two years of age. He was an athlete and a member of the Mohawk Golf Club. He leaves a widow and child. No cause has been given for this sad event.

JUDGE J. M. THOMAS.—It is with much regret that we note the death of Judge J. M. Thomas at his home in Irvington, N. Y., on November 7. He was for two terms Probate Judge of Ross County, Ohio. Subsequently he went to Cleveland to become president of the Cuyahoga Telephone Company. Up to a few months ago he was engaged in large independent telephone interests and was for six years president of the National Independent Telephone Association. He is survived by a widow and four children. The funeral will take place in New York City. There is no doubt that the earnest work done by Judge Thomas for several years was a potent factor in the general success of the independent telephone cause in the United States. He drew together the feeble elements and unrelated, even discordant parts of the independent system, secured united action on vital questions, particularly those of patent litigation, and saw his work crowned with success. Even to this day his efforts in the cause are not fully appreciated by those for whom he worked. A few years ago, Judge Thomas moved to New York, engaged in other enterprises outside the telephone field, and made his home at Irvington, N. Y. The personality of the man was strong and likeable and he won a host of friends in the electrical field.

PERSONAL.

MR. G. MARCONI has sailed again for England, but intends to return in December, when he proposes to resume Atlantic wireless telegraphy.

MR. W. J. CANADA, electrical engineer of the Appleyard Interurban Lines, of Ohio, has moved his office from Springfield to the general office at Columbus.

MR. ALLAN POLLOK, has again been appointed to the position of manager of the San Francisco Gas & Electric Company, which has been vacant since the resignation of Manager J. F. Lawless some months ago.

MR. ANSON R. TRACY, electrical engineer at the Minnesota state institution located in Faribault, Minn., has resigned the position held by him for the past seven years, to accept a position in the United States Weather Bureau at Boston, Mass.

MR. W. BOARDMAN REED, vice-president of the Bishop Gutta Percha Company, will act as president until the annual meeting in January, as provided by the company's by-laws, and in consequence of the death of Mrs. Helen Blitz, the late president.

MR. E. CANNON, president of the Northwest Electric Engineering Company, Portland, Ore., and representative of the Allis-Chalmers Co. in Oregon and Washington, is in New York for the purpose of consulting with the Allis-Chalmers people in regard to some big deals in his territory. He is stopping at the Imperial Hotel.

MR. R. S. HALE, formerly of the firm of Hale & Codman, of Boston, has severed his connection with that firm in order to accept a position as assistant to the general superintendent of the Edison Electric Illuminating Company of Boston. Mr. Codman will carry on the business in Holophane glass and the Wright demand meter formerly carried on by the firm.

MR. S. LAKE.—Mr. Simon Lake, inventor of the submarine torpedo boat which bears his name, returned to the United States on the steamer La Touraine last week, after a four months' absence in Europe. Mr. Lake declined to say anything regarding his movements while abroad, except that most of his time had been spent in Paris. He declined to talk regarding reported sales of his boats for participation in the war in the Far East.

MR. A. J. WURTS, of the Westinghouse Electric & Manufacturing Company, who recently resigned as manager of the Nernst Lamp Company, has been appointed constructing engineer for the Carnegie Technical Schools of Pittsburg. In accepting this new appointment, Mr. Wurts does not sever his connections with the Westinghouse Electric Company, but will continue there in his experimental and development work, which has been of so interesting and successful a character.

MR. C. A. SCHIEREN.—Ex-mayor Charles A. Schieren, says the *New York Tribune*, has been called the father of the English Lutheran Church in Brooklyn, and the title is by no means improper, as there is scarcely a church of that denomination in Brooklyn that has not been made possible by his aid. Not only has he encouraged the starting of such societies, but has made generous gifts to the building fund, and lent additional money on mortgages at a nominal rate of interest. He is considered the most prominent member of the English Lutheran Church in the United States. Only last week he made another gift to the cause by reducing the mortgage he holds on the property of the English Lutheran Church of the Messiah by $1000. Mr. Schieren is also always ready to lend his financial skill to the management of the various enterprises, the result of which is that the young English Lutheran churches are among the most flourishing of all the churches of equal age in that borough.

ALLIS-CHALMERS' PERSONNEL.—Mr. W. A. Nelson, who was appointed superintendent of equipment of the Allis-Chalmers Company, October 1, 1904, began his services with that company in August, immediately after his resignation became effective as assistant superintendent of the Westinghouse Electric & Manufacturing Company. During his connection of nearly five years with the Westinghouse Company, Mr. Nelson had immediate charge of the plans for the arrangement and location of machinery in the new East machine shop.

Prior to his connection with the Pittsburg Company, Mr. Nelson had similar duties at the works of Pratt & Whitney Company, going to Hartford from Fitchburg where he had been superintendent of the Simonds Rolling Machine Company for a number of years. Mr. Nelson will have duties in connection with all of the works of the Allis-Chalmers Company and his experience admirably qualifies him for making a success in this new undertaking. Mr. R. C. Wright, for several years in charge of the design of special tools and fixtures used in the manufacture of steam turbines at the East Pittsburg works of the Westinghouse Machine Company, has resigned to accept similar duties at the Milwaukee works of the Allis-Chalmers Company. Mr. Charles F. Barth has recently been appointed foreman of the steam turbine department at the West Allis works of the Allis-Chalmers Company. Mr. Barth resigned his position as foreman at the East Pittsburg works of the Westinghouse Machine Company, a position he had occupied for a number of years. Mr. C. A. Derby has resigned his position as assistant manager of the Lyon Cypress Lumber Company to join the selling staff of the Allis-Chalmers Company, in its sawmill department. Mr. Derby brings to his new position a valuable and varied experience, having been general manager of the F. B. Dubach Lumber Company and previously in the engineering department of the Colorado Fuel & Iron Company at Pueblo.

Trade Notes.

MR. G. M. GEST, the expert subway contractor of New York and Cincinnati, has been awarded at the St. Louis Fair the highest prize for conduit construction.

ELECTRIC FLATIRONS.—The General Electric Company, among the 20 other awards which it received from the Louisiana Purchase Exposition, has received a gold medal for electric flatirons.

JUNCTION BOXES.—The Fibre Conduit Company, Orangeburg, N. Y., in bulletin No. 25, refers to a recent installation of its junction boxes made in the Northfield schools of East Northfield, Mass.

PHOTO-ENGRAVING AND BLUE PRINTING.—The Adams-Bagnall Company, of Cleveland, Ohio, is sending out a folder in the interest of its type of enclosed arc lamp for photo-engraving and blue printing.

THE JAEGER MINIATURE LAMP MANUFACTURING COMPANY, Eighth Street and Fourth Ave., New York, is sending out to the trade an attractive little blotter advertising its miniature and telephone signal lamps.

THE FAMOUS FILTER COMPANY.—All apparatus in Machinery Hall at the St. Louis Exposition is supplied with lubricating oil from block 44, to which point the oil returns for filtration. The oil is forced through the supply pipes by two Worthington duplex pumps.

THE ELECTRIC GAS LIGHTING COMPANY, of Boston, is opening a branch sales office in San Francisco, at 519 Mission St., which will be in charge of H. G. Aylsworth as local manager. A full line of annunciators, switchboards, etc., will be carried in stock.

EXHAUST FANS.—The latest bulletin of the Emerson Mfg. Company, of St. Louis (No. 3056), is devoted to the subject of direct connected exhaust fans for alternating and direct current. Information is contained to guide in selecting the size of a fan for a given use.

MESSRS. H. M. BYLLESBY & CO., who are at present constructing the gas plant at Musgogee, I. T., have been retained as engineers by the Muskogee Electric Traction Company to design and construct a railway in the town of Muskogee, with an approximate trackage of 4.7 miles.

BOULTER ELECTRIC FURNACE MUFFLERS.—The Boulter Mfg. Company, 1617 North St., Philadelphia, Pa., is sending out a card calling attention to its mufflers for electric furnaces. This firm, which has been in business for sixty-nine years, makes a specialty of high grade fire brick for all purposes.

BLISS TOOLS.—E. W. Bliss & Co., of Brooklyn, N. Y., have been awarded the grand prize and a gold medal for tools and machines exhibited at the Louisiana Purchase Exposition, St. Louis, for superiority of workmanship, smoothness of action, ingenuity in design and highest quality of product.

THE WESCO SUPPLY COMPANY, of Seventh St. and Clark Ave., St. Louis, Mo., issues a neat little folder as to its Pardridge reflectors and other lighting specialties; also with regard to the Reynolds electric flasher which it handles. Both folders are clever and effective, and make their points admirably.

INDUCTION SPARKER.—The F. Bissell Co., Toledo, Ohio, in a circular just issued describes the "Security" induction sparker for gas and gasolene motors. The sparker is of the dynamo type, but without brushes, and has an output of 10 amperes, thus giving a very "fat" spark and insuring ignition.

THE CENTRAL ELECTRIC COMPANY, of Chicago, has found it necessary to increase its warehouse capacity about 50 per cent. and to add very largely to its other floor space. This addition will enable not only the carrying of a much larger stock, but will facilitate the more rapid handling of orders.

AMERICAN LAVA COMPANY, Chattanooga, Tenn., Mr. P. J. Kruesi, manager, announces that on December 1 it will move into a new factory with five times the present floor space and much additional machinery. It is now requesting customers to get their orders in so as to avoid delay by anticipating requirements and shipments.

TRANSMITTERS AND RECEIVERS.—The Dean Electric Company, Elyria, Ohio, has issued a pamphlet describing the Dean type of telephone transmitter receiver. Every part is described in detail with accompanying illustrations. To one desiring to obtain complete knowledge of the construction of a telephone transmitter receiver this pamphlet will be found of much interest.

DIXON'S GRAPHITE.—The Joseph Dixon Crucible Company, Jersey City, in a handsome pamphlet with a very effective cover, points out to automobilists and motor boat owners the advantages of graphite for motor lubrication. For this purpose a special graphite (No. 635) is manufactured. Another publication of the same company is a folder setting forth the merits of silica-graphite paint for the protection of steel.

THE CROCKER-WHEELER COMPANY, Ampere, N. J., is supplying the electric light and power plant for the U. S. battleship "Connecticut." She carries the largest plant of the kind ever installed. It will have a capacity of 800-kw, consisting of eight Crocker-Wheeler generators direct connected to Forbes marine type engines. The company has issued a neat illustrated postal card giving data about the battleship.

MESSRS. ROSSITER, MACGOVERN & COMPANY, 17 Battery Place, New York, say they find that an impression has been created that they have given up their St. Louis office and have withdrawn from that field. They state, therefore, that while they have disposed of their repair shop in St. Louis, they have nevertheless retained their office and their entire office force at their old location, and they are carrying on their customary business as usual.

THE KILBOURNE & CLARK COMPANY, of Seattle and San Francisco, is making arrangements to open a branch office in Los Angeles early in November for the sale of Nernst lamps and general electrical supplies. The new office will be under the general supervision of the San Francisco branch, of which H. G. Aylsworth is local manager. Mr. Aylsworth reports that they are having very good business all along the coast in the sale of Nernst lamps.

MACHINE TOOL CONTROLLERS.—The Ward Leonard Electric Company, of Bronxville, N. Y., has issued a new bulletin covering its SKB type machine tool controllers. This controller consists of switch, fuses, overload and no-voltage release motor starter and field rheostat, the field rheostat being so interlocked with the starter that the motor cannot be started under conditions of weakened field. The company is doing an extensive business in this line with the machine tool trade.

ELECTRICAL AND STEAM MACHINERY.—Practically all of the 96 pages of the October catalogue of Rossiter, MacGovern & Company, Inc., are taken up by the lists of electrical, steam and other engineering apparatus carried in stock by this well-known house. The list includes direct and alternating current generators, motors of all kinds, lamps, transformers, switchboards, steam, gas and gasolene engines, pumps, boilers, cars, snowplows, etc. There seems to be everything on hand to fit any requirement and the company guarantees that every piece of apparatus that it sells and installs to be first class.

PRINTING PRESS ELECTRIC DRIVE.—The Sprague Electric Company has issued a handsome bulletin (No. 221) having for its subject direct-current motor equipment for printing presses and allied machines. The illustrations comprise more than four score excellent half-tones showing direct-current motors and appliances in detail, and views of numerous machines to which they have been applied. The text describes the various types of equipments, including descriptions of the various means of connecting up motors with machines. Those interested in catalogue making will find much to admire in the handsome execution of this pamphlet. The border in colors surrounding each page is particularly effective.

THE SMITH STORAGE BATTERY COMPANY, Binghamton, N. Y., reports business conditions very favorable. Mr. A. C. Rahe, the manager of the company, on a recent trip through the central part of Pennsylvania, closed contracts for three installations of its tray batteries. One is with the Harrisburg Light, Heat & Power Company, to be used to equalize the lighting plant load; another with a lighting plant for the Warrensville Sanitarium near Reading, and the third at Mertztown for a large isolated plant for residences and a hotel. The Smith Storage Battery Company is desirous of establishing agencies in all the principal cities of this country. It is already in negotiation with parties in several cities.

THE INTERNATIONAL TELEPHONE MANUFACTURING COMPANY, of Chicago, it is said, is making its central energy, as well as its generator-call, wall and desk telephones, completely avoiding the use of any of the exposed metal parts forming a part of the circuit at any time, absolutely preventing the user from receiving an electrical shock when using the telephone. This point is becoming more and more an important feature in telephone apparatus in view of the many accidents that are constantly occurring from the use of instruments in which circuits are completed through outside metal parts. One of the most peculiar accidents of this kind recently occurred at Indianapolis, Ind., as reported from the *Chicago Tribune*, October 29. The International Company in designing its apparatus considered these points as one of the most essential in the telephone system, especially for large cities or even rural exchanges where there is considerable danger from lightning, and it has carried out in every detail the idea of perfectly concealing all working parts of the apparatus and insulating all exposed metal parts throughout its entire system.

THE AUTOMATIC ELECTRIC COMPANY, of Chicago, announces that the Jury of Awards of the Louisiana Purchase Exposition has awarded the grand prize to its exhibit of automatic telephones and switchboards. This award is for general excellence in Group 70, which includes all forms of telephone switchboards, telephones, telephone apparatus, appliances, appurtenances and supplies. The Automatic Electric Company is the only independent telephone manufacturer to receive the grand prize, which is the highest award in the power of the Exposition officials to make. The company's exhibit is one of the most interesting and noteworthy at the Exposition. It occupies a conspicuous position in Section 24, Palace of Electricity, and is housed in a splendidly appointed pavilion of its own, as already illustrated in our pages. The exhibit proper consists of a complete automatic telephone exchange of the 10,000-type, divided into two switchboards and having power equipment and all other accessories. To this exchange is connected a large number of telephones scattered throughout the exhibit and the Palace of Electricity. The automatic service has been in constant use by the officials of the electrical building since the opening of the Fair and they praise it highly. The exhibit is in charge of Harry S. Durant, of the sales department of the Automatic Electric Company, assisted by James Strasburg, of the mechanical department. The Automatic Electric Company has within the past two years equipped more than sixty cities in the United States with its automatic telephone apparatus.

Record of Electrical Patents.

UNITED STATES PATENTS ISSUED NOV. 1, 1904.

[Conducted by Rosenbaum & Stockbridge, Patent Attys., 140 Nassau St., N. Y.]

773,550. FRAME FOR ELECTRIC MACHINES; Carl Dihlmann, Berlin, Germany. App. filed Nov. 23, 1901. The cores of large alternators are mounted within a tubular girder-frame for support.

773,508. SELF-PLAYING MUSICAL INSTRUMENT; Charles A. Shaffer, Philadelphia, Pa. App. filed Dec. 9, 1903. Details.

773,621. COMBINED TROLLEY WIRE SPLICE AND SUPPORT; Alonzo B. Allison, Canton, Ohio. App. filed Feb. 15, 1904. Details of a trolley wire clip.

773,626. KNIFE SWITCH; William F. Bossert, Utica, N. Y. App. filed March 7, 1904. A special form of clip or post made out of bent up flat material.

773,685. STORAGE-BATTERY ELECTRODE AND PROCESS OF MAKING SAME; Elmer A. Sperry, Cleveland, Ohio. App. filed Jan. 28, 1904. (See page 828.)

773,686. STORAGE BATTERY; Elmer A. Sperry, Cleveland, Ohio. App. filed Feb. 11, 1904. (See page 828.)

773,710. CABLE HANGER; Douglas B. Bronson, Chicago, Ill. App. filed April 17, 1903. A U-shaped spring having a bushing inside for engagement with the cable and having an opening in its bend for a fastening screw and a bolt passing through its free ends to clamp the cable.

773,725. RECEPTACLE; Philip H. Fielding, New York, N. Y. App. filed April 5, 1904. This receptacle is constructed especially for high potential lamps; the sleeve contact is arranged a considerable distance above the center contact so as to increase the arcing distance and prevent short-circuiting by the collection of moisture within the receptacle.

773,733. INSULATOR; Leon W. Greene, Brooklyn, Mich. App. filed Nov. 10, 1903. A porcelain tube having a flange at one end and a series of circular grooves at the other end; when inserted through a wall it is held in place by passing a ring over one of the grooves immediately adjacent to the surface of the wall, thus preventing movement of the insulator in either direction.

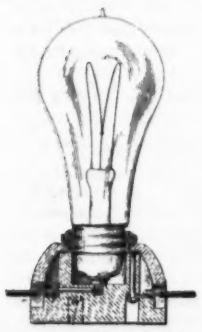
773,774. ELECTRIC ARC LAMP; Lorens S. Anderson, Stockholm, Sweden. App. filed April 15, 1902. Two electrodes connected in series and a third electrode forming a bridge between them, combined with means for regulating the electrodes independently of each other.

773,777. RHEOSTAT; William Baxter, Jr., Jersey City, N. J. App. filed March 5, 1903. Resistance pencils are mounted in a frame and held at their extremities between metal end pieces which are forced toward each other by springs to maintain a good contact.

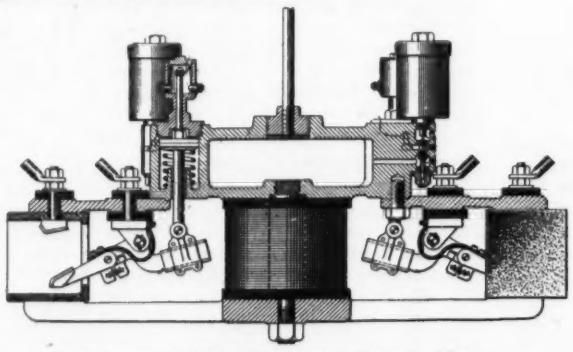
773,805. INCANDESCENT ELECTRIC LAMP; Albert W. W. Miller, South Orange, N. J. App. filed Sept. 29, 1902. The object is to produce a removable lamp base. The stem of the lamp is plugged with cement which retains a porcelain button in place against the end of the lamp; the center and sleeve contacts are attached to this button and mechanically supported by a wrapping of wire.

773,821. ELECTRIC FURNACE; Charles P. Steinmetz, Schenectady, N. Y. App. filed May 24, 1900. (See page 827.)

773,827. ROENTGEN RAY TUBE; Elihu Thomson, Swampscott, Mass. App. filed Feb. 14, 1898. A method of regulating the degree of density of a vacuum tube consisting in causing rays under the influence of a decreased intensity to liberate gas from an agent within the tube.



773,725.—Receptacle.



773,833.—Controlling System for Electric Motors.

773,832. CONTROLLING SYSTEM FOR ELECTRIC MOTORS; George Westinghouse, Pittsburg, Pa. App. filed March 18, 1903. The contact members of a number of switches are arranged in a circle around a central inlet for pneumatic pressure and electro-magnetically actuated valves control the various contact members, said valves being themselves controlled by a main governing switch.

773,833. CONTROLLING SYSTEM FOR ELECTRIC MOTORS; George Westinghouse, Pittsburg, and Louis M. Aspinwall, Wilkinsburg, Pa. App. filed May 1, 1903. Relates to the same kind of control system as referred to in patent last mentioned and involves the use of an independent circuit and source of current for the governing switch.

773,836. CONTROLLING SWITCH; Harold E. White, Schenectady, N. Y. App. filed April 23, 1904. A generator, a motor, a separate source of excitation for both fields, a resistance and a controlling switch arranged to include variable portions of the resistance in series with either field.

773,837. ELECTRIC METER; Eddy R. Whitney, Lynn, Mass. App. filed Feb. 29, 1904. In this meter the torque is proportional to the square of the current and to make the revolutions proportional to such quantity, the damping device is made proportional to the first power of the speed.

773,838. THERMO ELECTRIC GENERATOR; Merle J. Wightman, New York, N. Y. App. filed July 13, 1900. The elements of the couple are constructed with circulation passages for a cooling medium.

773,839. THERMO ELECTRIC GENERATOR; Merle J. Wightman, New York, N. Y. App. filed April 8, 1901. A modification of the preceding patent.

773,853. ELECTRIC KILN; Frederick E. Dickinson, Kendallville, Ind. App. filed Jan. 12, 1903. A number of electric arcs are arranged to heat the air in circulatory passages extending through the kiln.

773,867. PORTABLE ELECTRIC WINCH; James Heywood, Philadelphia, Pa. App. filed March 14, 1904. This is a heavy truck carrying an electric motor and a winch geared thereto for operation about the streets.

773,868. AUTOMATIC ELECTRICAL SIGNALING SYSTEM; Franklin S. Holmes, New York, N. Y. App. filed April 16, 1903. A burglar alarm system combined with a telephone system and comprising a signaling device operating constantly and at regular intervals within the vision or hearing of the central office telephone operator; an irregularity in the signals indicates a change in the circuit at the protected area.

773,869. AUTOMATIC ELECTRICAL SIGNALING SYSTEM; Franklin S. Holmes, New York, N. Y. App. filed March 19, 1904. Relates to a system similar to that of the preceding patent.

773,870. AUTOMATIC ELECTRICAL SIGNALING SYSTEM; Franklin S. Holmes, New York, N. Y. App. filed March 25, 1904. A further extension of the last two patents.

773,880. SYNCHRONIZING DEVICE FOR DYNAMO-ELECTRIC MACHINES; Louis C. Marburg, Schenectady, N. Y. App. filed March 7, 1904.

773,881. COMMUTATOR; Maurice Milch, Schenectady, N. Y. App. filed March 19, 1904. A commutator for alternating current motors in which the segments are insulated by a material that becomes an electrical conductor when heated, so that after the machine has been started, the heat generated in the commutator will short circuit the armature and the motor will run thereafter as a simple induction motor.

773,893. TROLLEY HARP; Alson C. Ralph, Somerville, Mass. App. filed March 11, 1904. Carbon brushes carried in the harp are pressed by springs against the trolley wheel for contact.

773,917. SYSTEM OF ELECTRICAL DISTRIBUTION; William L. Bliss, Brooklyn, N. Y. App. filed Feb. 3, 1902. Details of a system comprising a generator, a storage battery and automatic means for reducing the charging effect of the generator when the battery is charged to a predetermined point.

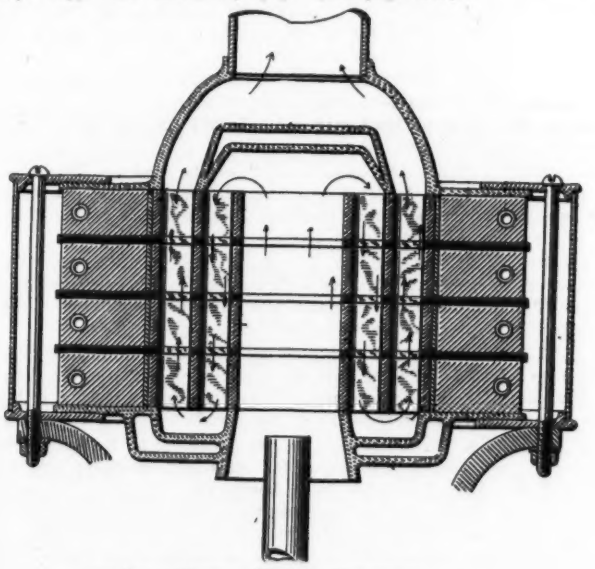
773,918. MEANS FOR EXCITING DYNAMO ELECTRIC GENERATORS; William L. Bliss, Brooklyn, N. Y. App. filed Feb. 26, 1902. A system of distribution involving a normally open armature circuit, a shunt field, a storage battery supplying the field, a resistance between the field and armature and an automatic switch between the battery and field.

773,930. ELECTRIC MOTOR; Frederick B. Duncan, Madison, Wis. App. filed May 10, 1901. A motor transmitting power through a flexible shaft, is mounted upon a frame having various axes permitting it to turn to any position desired.

773,931. ELECTRICALLY CONTROLLED MONOGRAM SIGN; Mortimer Du Perow, Washington, D. C. App. filed May 9, 1904. The face of the sign has openings through which the light from a single lamp behind is thrown, and electro-magnets are arranged to throw shutters across some of the openings so that the remainder will define a certain letter or design.

773,937. TESTING THE MAGNETIC QUALITIES OF MATERIALS; Frank Holden, Rugby, Eng. App. filed July 6, 1903.

773,941. MANUFACTURE OF CELLULOSE; Carl Kellner, Vienna, Austria-Hungary. App. filed March 18, 1903. (See page 828.)



773,839.—Thermo Electric Generator.

773,950. ELECTRIC TURRET OPERATING MECHANISM; Osborn P. Loomis, Newport News, Va. App. filed Dec. 16, 1903. A special arrangement of two electric motors with sets of speed gears and electro-magnetic clutches for rotating the turret of a war vessel at variable speeds.

773,961. STORAGE BATTERY; Charles B. Morgan, Cleveland, Ohio. App. filed April 18, 1904. (See page 828.)

774,001. TRACK STRUCTURE; Louis Steinberger, New York, N. Y. App. filed March 15, 1904. An insulator for third rails comprising a knob of insulating material covered by a metallic shield having a seat for the rail in which it is permitted to adjust its position slightly.

774,018. ALTERNATING-CURRENT MOTOR; Caspar Wust-Kunz, Seebach, Switzerland. App. filed July 20, 1901.

774,043. TROLLEY; William R. Cooper, East St. Louis, Ill. App. filed May 21, 1904. The trolley pole is composed of two telescoping sections with a packing between them to render the pole water-tight.

774,049. PROCESS OF ELECTROLYTICALLY PRODUCING LEAD-PEROXIDE LAYERS UPON POSITIVE ACCUMULATOR; Julius Diamant, Raab, Austria-Hungary. App. filed Jan. 4, 1904. (See page 828.)

774,059. ELECTRICAL ALARM FOR TELEPHONE CALL-BELLS; John W. Fouche, Ryan, Va. App. filed May 2, 1904.

774,077. MOTOR CASING; Gustav E. Jacobson and Charles Anderson, Newark, N. J. App. filed July 25, 1904. Details.

774,085. TROLLEY POLE CONTACT; John J. Lacknor and Andrew J. Curtis, East Williamson, N. Y. App. filed May 5, 1904. The wheel is swivelled upon a vertical axis so as to accommodate itself to inaccuracies in the wire.

774,090. ALTERNATING-CURRENT SELECTOR; Hermann Lemp, Lynn, Mass. App. filed Dec. 1, 1897.

774,115. CONDENSER; John Splitdorf, New York, N. Y. App. filed Oct. 19, 1903. Two continuous conducting strips and an intervening dielectric are rolled into a bundle whose opposite terminals allow connection with a source of current whereby the discharge will be across the roll instead of lengthwise of the strips.

774,118. ROENTGEN RAY TUBE; Elihu Thomson, Swampscott, Mass. App. filed April 26, 1902. The apparatus patent corresponding to the method patent of the same patentee above mentioned.

774,138. EXCITING VACUUM TUBES; Hermann Lemp, Lynn, Mass. App. filed Dec. 1, 1897.

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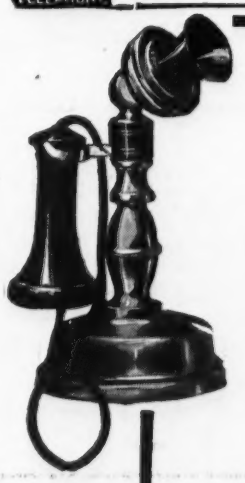

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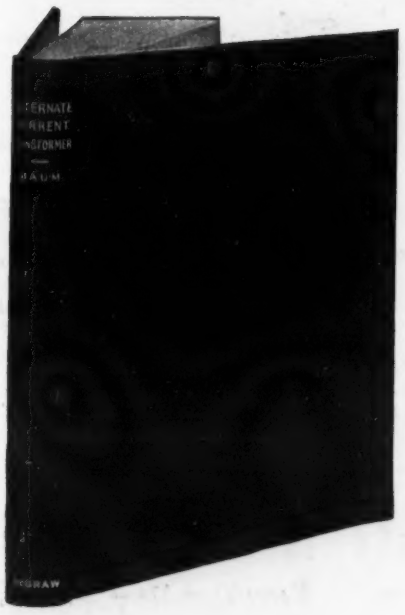

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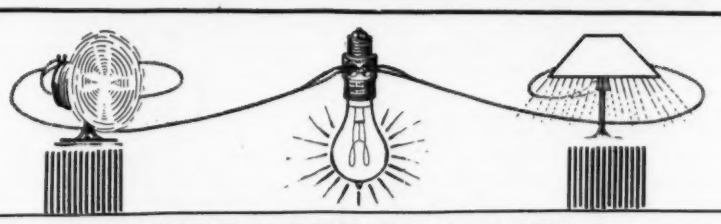

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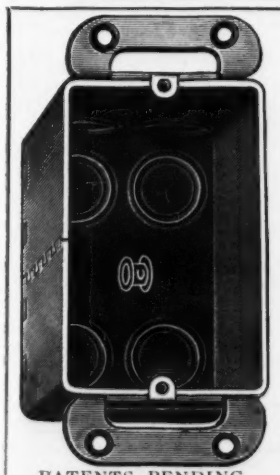

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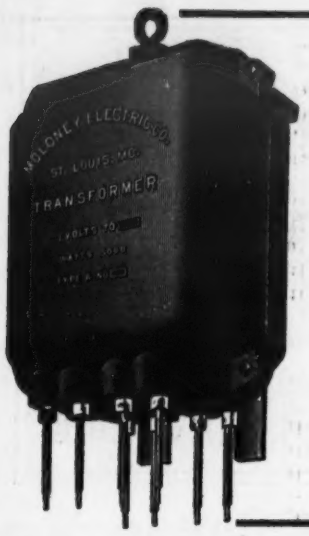

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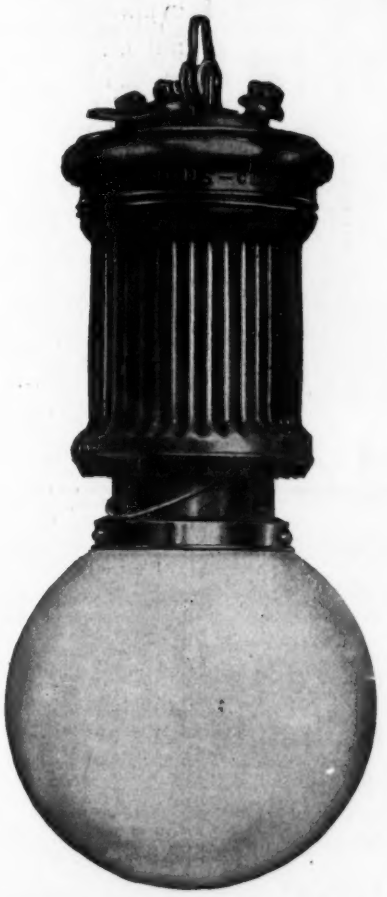

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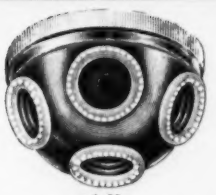

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Bossert Electric Construct. Co.
D. & W. Fuse Co.
General Incandescent Arc Light Co.
Johnson & Morton.
Sarco Company.

LAMP ADJUSTERS.
Incan. Electric Lt. Manip. Co.

LAMPS, ARC.
Adams-Bagnall Elec. Co.
Allgemeine Elektricitats Gesellschaft.
American Electrical Mfg. Co.
Anderson Mfg. Co., A. & J. M.
Bissell & Co., F.
British Thomson-Houston Co.
Brush Elec'l Engineering Co.
Clark & Mason.
Doubleday-Hill Elec. Co.
Fort Wayne Electric Works.
General Electric Co.
General Incandescent Arc Light Co.
Gregory Electric Co.
Helios Mfg. Co.
Jandus Electric Co.
Stanley Electric Mfg. Co.
Toerring Co., C. J.
Universal Electrical Wks.
Warner Arc Lamp Co.
Western Electric Co.
Westinghouse Electric & Mfg. Co.

LAMP COLORING COMPOUND.
Webster Chemical Co.

LAMP GUARDS.
Greenwood & Daggett Co.

LAMP HOLDERS.
Crescent Co.

LAMPS, INCANDESCENT.
Banner Elec. Co.
Bissell Co., F.
British Thomson-Houston Co.
Brush Elec'l Engineering Co.
Central Electric Co.
Buckeye Electric Co.
Columbia Inc. Lamp Co.
Dwyer Machine Co.
Edison Dec. & Min. Lamp Co.
Franklin Elec. Mfg. Co.
General Electric Co.
General Incandescent Arc Light Co.
Germania Elec. Lamp Co.
Hall, William Albert.
Howard Miniature Lamp Co.
Machado & Roller.
Missouri American Elec. Co.
New York & Ohio Co.
Sawyer-Man Electric Co.
Shelby Electric Co.
Standard Electrical Mfg. Co.
Tipless Lamp Co.
Wesco Supply Co.
Western Electric Co.

LAMPS, MINIATURE.
American Endoscopic Co.
Edison Dec. & Min. Lamp Co.
Howard Miniature Lamp Co.
Jaeger Min. Lamp Co.
Tipless Lamp Co.

LAMPS, VAPOR.
Hewitt & Co., Cooper.

LAMP REPLACERS.
Incan. Electric Lt. Manip Co.

LATHES.
Barnes Co., B. F.
Barnes Co., W. F. & John.
Garvin Mch. Co.
Hardinge Bros.
Niles-Bement-Pond Co.
Sebastian Lathe Co.
Seneca Falls Mfg. Co.

LETTERS FOR ELECTRIC SIGNS.
Electric Motor & Equipment Co.

LINEMEN'S TOOLS.
Bissell Co., F.
Cincinnati Tool Co.
Klein & Son, Mathias.
Smith, Hemenway & Co., Corp.
Standard Tool Co.
Utica Drop Forge & Tool Co.

LIGHTNING ARRESTERS.
Cook, Frank B.
D. & W. Fuse Co.
Garton-Daniels Co.
Muralt & Co.
Stanley Elec. Mfg. Co.
Viaduct Mfg. Co.
Westinghouse Elec. Mfg. Co.

LUBRICATORS.
Crane Co.
Lunkenheimer Co.

MACHINERY FOR MAKING ELECTRIC LAMPS.
Dwyer Machine Co.

MACHINE TOOLS, ETC.
Barnes Co., B. F.
Barnes Co., W. F. & John.
Garvin Mch. Co.
Niles-Bement-Pond Co.
Pratt & Whitney Co.
Sebastian Lathe Co.
Seneca Falls Mfg. Co.
Standard Tool Co.
Watson-Stillman Co.

MAGNETS, LIFTING.
Electric Controller & Supply Co.

MARINE ELECTRIC EQUIPMENT.
Electro-Dynamic Co.
Kilbourne & Clark Co.

MAST ARMS.
Brady, T. H.

MEDICAL APPARATUS.
Pignolet, Louis M.
Splitdorf, C. F.

METALS.
American Platinum Works.
Baker & Co., Inc.
Croselmire & Ackor.
Leslie & Co., A. C.
Phosphor Bronze Smelting Co.

METAL POLISH.
Allen Co., Inc., L. B.
Hoffman, George W.

MICA.
Hall, William Albert.
Johns-Manville Co., H. W.
Mica Insulator Co.
Munsell & Co., Eugene.
Schoonmaker Co., A. O.
Vance, D. T.

MILLING MACHINES.
Niles-Bement-Pond Co.
Pratt & Whitney Co.

MINING MACHINERY.
General Electric Co.
Jeffrey Mfg. Co.
Muralt & Co.
Power & Mining Machinery Co.

MODEL MAKERS.
Baillard, E. V.
International Brass & Electric Co., Inc.
Parsell & Weed.

MOTOR CLOTH AND INSULATING PAPERS.
Standard Paint Co.

NAME PLATES.
Becker Eng. Co., A.
Hall, William Albert.

NIPPERS AND PLYERS.
Cincinnati Tool Co.
Smith, Hemenway & Co., Corp.
Utica Drop Forge & Tool Co.

NON-MAGNETIC WATCHES.
Becken, A. C.

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NOZZLES.
Doble Co., Abner.
McCullough-Dalzell Crucible Co.

NUTS.
International Brass & Elec. Co.
National Acme Mfg. Co.

OIL.
Kellogg & Co., E. H.

OIL AND GREASE CUPS.
Bay State Stamping Co.
Crane Co.
Lunkenheimer Co.

OIL FILTERS AND PURIFIERS.
Burt Mfg. Co.

OUTLET BOXES.
Bossert Electric Construction Co.
Chicago Fuse Wire & Mfg. Co.
Sarco Company.

OVERHEAD RAILWAYS.
United Telpherage Co.

PACKING.
Jenkins Bros.
Johns-Manville Co., H. W.
Peerless Rubber Mfg. Co.

PAINTS, VARNISHES, ETC.
Macon-Evans Varnish Co.
Standard Paint Co.
Sterling Varnish Co.

PATENT ATTORNEYS.
Byrnes & Townsend.
Dyer & Dyer.
Goepel & Niles.
Rosenbaum & Stockbridge.
Thompson, Edward P.
Townsend & Decker.

PHOTOMETERS.
Dwyer Machine Co.
Electric Motor & Equipment Co.

PHOTOMETER STANDARDS.
Electrical Testing Laboratories.

PHOSPHOR BRONZE.
Phosphor Bronze Smelting Co.

PHOSPHORIZERS.
McCullough-Dalzell Crucible Co.

PINIONS.
New Process Rawhide Co.

PLATINUM.
American Platinum Works.
Baker & Co., Inc.
Croselmire & Ackor.

PLUGS.
Paiste Co., H. T.

PLUMBAGO.
McCullough-Dalzell Crucible Co.

POLES, TIES, BRACKETS, PINS, ETC.
Bissell Co., F.
Brady, T. H.
Kellogg S. B. & Supply Co.
Lindsley Bros. & Co.
Phelan, D. W.
Porter Cedar Co.
Sand Point Cedar Co.
Sterling & Son, W. C.
Strock, S. C.
Valentine-Clark Co.
Worcester Co., C. H.

PORCELAIN MANUFACTURERS.
Bellevue Porcelain Works.
Empire China Works.
Hartford Faience Co.
Imperial Porcelain Works.
Locke Insulator Mfg. Co.
Pass & Seymour, Inc.
Sears, H. D.
Thomas & Sons, R.
Trenton Porcelain Co.

POWER TRANSMISSION MACHINERY.
Case Mfg. Co.
Jeffrey Mfg. Co.
Hunter Machine Co., James.
Link-Belt Engineering Co.
Mead-Morrison Mfg. Co.
Muralt & Co.
Niles-Bement-Pond Co.

PRESSES, DIES AND SPECIAL MACHINERY.
Hunter Machine Co., James.
Niles-Bement-Pond Co.
Watson-Stillman Co.

PULLEYS, SHAFTING, COUPLINGS, ETC.
Hunter Machine Co., James.
Jeffrey Mfg. Co.
Niles-Bement-Pond Co.
Smith Co., S. Morgan.

PUMPS, ELECTRIC.
Commercial Electric Co.
Emerson Elec. Mfg. Co.
Quimby, Wm. E.
Worthington, Henry R.

PUMPS, OIL.
Lunkenheimer Co.

PUMPS, STEAM.
McGowan Co., J. H.
Morris Company, I. P.
Quimby, Wm. E.
Worthington, Henry R.

PUMP VALVES, RUBBER.
Crosby Steam Gage & Valve Co.

PUNCHES AND SHEARS.
Niles-Bement-Pond Co.
Pratt & Whitney Co.

PUSH BUTTONS.
Edmonstone Co.
Sarco Company.